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The impact of an informal science learning environment on the environmentally responsible behavior of adults: a case study

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**THE IMPACT OF AN INFORMAL SCIENCE LEARNING ENVIRONMENT ON
THE ENVIRONMENTALLY RESPONSIBLE BEHAVIOR OF ADULTS:
A CASE STUDY**

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Educational Theory, Policy, and Practice

by

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May 2012

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DEDICATION

In loving memory of
Margaret A. and Robert F. March

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I would like to thank Jim Wandersee, towards whom I feel more gratitude than words can properly express. Not only did you challenge me to succeed, but the experiences and opportunities you provided me over the last five years will be invaluable in the years ahead. I am grateful too for the support and patience of my committee members throughout this process. I am also indebted to several graduate students for their guidance, most especially Rachel Jarreau and Danielle Alfandre; thank you for blazing the trail.

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ABSTRACT

Since environmental education's emergence in America, the field has been primarily focused on increasing environmental awareness, attitudes, knowledge, skills, and behavior. Yet the nation's overall level of environmental literacy, especially with regard to the performance of environmentally responsible behaviors, continues to be low (Coyle, 2005). Unlike school-based education programs, which only reach a segment of the population, informal sites have the potential to influence learners of many ages and diverse backgrounds (NRC, 2009). Informal science learning environments (ISLEs) have been shown to provide personally meaningful learning experiences and have the potential to impact environmentally responsible decisions and actions (Falk, 2005). Yet models of behavior change which have been traditionally used in environmental education have not been entirely successful in informal environments.

This exploratory case study attempted to discover which aspects of a museum exhibit might affect intended and actual environmentally responsible behaviors (ERBs). Qualitative techniques were used to collect and analyze data from 31 highly engaged adult visitors to the *Altered State: Climate Change in California* exhibit at the California Academy of Sciences. Certain messages and design elements in this exhibit were found to have a greater impact on participants' intentions and behaviors. Hands-on activities appeared to have a larger effect, as did direct messages about specific, simple actions. Positive reinforcement of existing ERBs also seemed to have a direct influence on future actions. All participants voiced concerns about societal and cultural barriers to pro-environmental actions, but those who performed fewer ERBs were more likely to discuss belief-based barriers to change. These results have implications for future ISLE exhibits related to taking action for the environment.

1. INTRODUCTION

This chapter begins with a brief history of both the field of environmental education and the concept of environmental literacy in the United States. It also establishes the rationale for my research and begins to situate this work within the existing body of literature relating to environmentally responsible behavior. It outlines the study's purpose, questions, and the unique setting offered by the California Academy of Sciences and the *Altered State: Climate Change in California* exhibit. This introduction also attempts to provide readers with a clear understanding of my perspectives and biases as a researcher. It ends with frequently used terms and acronyms.

1.1 Background

In the last 50 years, rapid technological advancement combined with exponential human population growth has drastically increased both the rate of natural resource consumption and the amount of air, water, and land pollution. This has resulted in substantial harm to natural ecosystems, biodiversity loss, and climate change. Threats to human health are also increasing due to overcrowding and shortages of adequate food, clean water, and basic sanitation. Urbanization exacerbates these issues; as countries become more industrialized, people tend to migrate from agricultural to urban areas. Worldwide, there are now more people living in cities than rural areas, with over 1 billion people in urban slums (Schneps et al., 2007). Global urbanization may have significant consequences for nature. It also has the potential to diminish man's "intimate association and interaction with natural resources... and with it, his awareness of his dependency on them" (Stapp et al., 1969, p. 30).

Others have voiced similar concerns. Louv (2005) called the increasing disconnect between the younger generation and the environment "nature-deficit disorder." He attributed

this trend to a number of factors, including a lack of access to natural areas and an increased dependence on technology for entertainment. E.O. Wilson coined the term “biophilia” to explain man’s instinctive affinity for life and other living things; according to his biophilia hypothesis, the continued degradation of the environment has serious implications for man’s physical and emotional well-being (Kellert & Wilson, 1993).

The field of environmental education (EE) emerged in the United States mainly as a response to increasing concerns about the health of both human and natural systems (Disinger, 1983). Since its beginning, the scope and direction of environmental education has never been fully agreed upon by its practitioners (Hungerford, 2010). However, the majority of EE efforts over the last 40 years have focused on increasing learners’ environmental awareness, knowledge, attitudes, skills, and actions. A learner who successfully achieves a high level of proficiency within each of these categories is considered environmentally literate (Roth, 1992).

Many would argue that the primary purpose of environmental education is to create an environmentally literate society, able to understand environmental issues and willing to take positive action to address them (National Environmental Education Advisory Council [NEEAC], 2005). A number of different organizations have developed recommendations for EE with the goal of increasing environmental literacy. Arguably the most comprehensive set of EE frameworks in the United States today is the North American Association for Environmental Education (NAAEE)’s Guidelines for Excellence, which informs many U.S. environmental education programs (Simmons, 1995; Volk & McBeth, 1998).

Environmental literacy is particularly important in developed nations. Technologically advanced countries are some of the worst environmental offenders. For example, Americans

make up less than 5% of the world's population, yet annually we are responsible for consuming 23% of the global petroleum supplies and releasing 5.8 billion metric tons of carbon dioxide into the atmosphere (United States Energy Information Administration, 2010). These numbers are especially concerning because people living in developing nations often hope to emulate the lifestyle (and therefore the consumption, production, and pollution patterns) of those who reside in developed nations such as the U.S. This suggests the environment will continue to degrade as more societies become industrialized unless the developed regions of the world adopt more sustainable practices.

The performance of environmentally responsible behaviors (ERBs) is frequently identified as the most important component of environmental literacy. It is important for learners to develop the desire to act in certain ways and the ability to determine which behavior choices are appropriate, but true literacy is only reached when those actions are carried out (Roth, 1992). According to Short (2010):

A citizenry capable of understanding the complexity of environmental issues and actively participating in their resolutions is vital. The ultimate goal of environmental educators should be to facilitate the creation of this active citizenry. (p. 7)

Environmental education has the potential to help Americans learn how to take appropriate actions, both individually and collectively, to address environmental issues (Potter, 2010).

1.2 Rationale

In the last 40 years, global concerns about the environment and human health have steadily increased. During that same period of time, our national environmental education program has improved greatly in both structure and focus. Yet recent studies indicate a low level of environmental literacy persists among American children and adults. For example, Reynolds, Bostrom, Read, and Morgan (2010) found Americans' mental models about

climate change were relatively unchanged between 1992 and 2009. Similarly, Coyle (2005) reported that even though most American adults care about the environment and are aware of environmental problems, they answer more than 75% of basic environmental literacy questions incorrectly and fail to comprehend more complex environmental issues. Studies of children in the U.S. have reported similar trends (McBeth & Volk, 2010). Participants in these studies had high levels of environmental awareness, but only a moderate amount of ecological knowledge. Further, they lacked the critical thinking and decision-making skills to resolve environmental issues and failed to perform many environmentally responsible behaviors.

Classroom instructional techniques which have focused on increasing environmental awareness, knowledge, and skills have been shown to have positive impacts on students' ERBs (Hines, 1984; Hsu, 2004). However, many Americans do not exhibit the ERBs associated with a high level of environmental literacy. Clearly, school-based EE programs are struggling to have significant long-term impacts on environmentally responsible decisions and actions.

Part of the problem may be a lack of consensus about the best way to change behavior using environmental education. Many EE researchers and practitioners have used theories of learning to guide the development of curricular materials. As discussed above, efforts of this type have been shown to be somewhat successful in formal education settings. Conversely, other professionals have suggested methods for promoting ERBs which are grounded in theories of human social behavior. These approaches involve identifying the motivations which underlie specific behaviors, such as values, beliefs, or norms. Social behavior frameworks have been successfully used to modify behavior in the general public, but have

mainly been researched outside of educational environments. The possibilities and limitations associated with both of these standpoints are discussed in detail in chapter 2.

Regardless of how school-based programs are developed, schools only reach a segment of the population and only for a relatively short period of time. The majority of learning which occurs over a person's lifetime takes place outside of formal education (Falk & Dierking, 2010). Free-choice learning experiences (e.g., watching a documentary, bird watching, visiting a museum) may be a critical part of maintaining environmental literacy and the willingness to perform ERBs into adulthood. One type of free-choice learning experience involves visiting an informal science learning environment (ISLE) such as a zoo, botanic garden, science museum, or national park. These locations not only provide important reinforcing experiences for school-based learning, they bring science learning opportunities to people of all ages and backgrounds (National Research Council [NRC], 2009).

Informal science learning environments have been shown to be places where meaningful learning can take place (Falk & Dierking, 2000). As such, they have the potential to positively impact the pro-environmental behaviors of visitors. A small number of studies have found visitors do intend to perform conservation behaviors (e.g., Dierking, Adelman, Ogden, Lehnhardt, Miller, & Mellen, 2004; Swanagan, 2000). Yet ISLEs have experienced difficulty in promoting lasting changes in ERBs (Adelman, Falk, & James, 2000; Dierking, et al., 2004; Smith, 2009). The role these settings play in influencing pro-environmental behaviors has not been fully researched. It is still unknown what personally meaningful experiences people have while visiting an exhibit about behavior change, or how these experiences affect their decisions and actions. There is also a lack of research into how design elements and messages might be influencing visitors' behavior. This study was an attempt to

uncover how one exhibit impacted visitors' environmentally responsible intentions and behaviors, to better understand how to promote behavior change in the American public.

1.3 Study Objectives

The primary goal in conducting this exploratory case study was to discover how one museum exhibit might influence the environmentally responsible intentions and behaviors of adult visitors. My secondary goal was to use the insights gained in this study to develop suggestions for the improvement of future exhibits about environmental topics.

The central research question of this study was: How does the *Altered State: Climate Change in California* exhibit influence the intended and actual environmentally responsible behaviors of adult visitors to the California Academy of Sciences?

Five sub-questions guided specific aspects of the study:

1. What are visitors' intentions regarding their performance of environmentally responsible behaviors immediately after experiencing this exhibit?
2. How do these intentions compare to actual self-reported behaviors several weeks later?
3. What reasons do visitors give for differences between their intentions and actual behaviors, if any?
4. What components of the exhibit's design seem to influence visitor intentions and/or behaviors?
5. What environmental messages do visitors appear to take from the exhibit, and how do they seem to influence visitor intentions and/or behaviors?

Sub-question 1 attempted to discover behaviors (e.g., recycling, carpooling, eating less meat) that visitors intended (i.e., wanted, hoped, or planned) to do as a result of experiencing the *Altered State* exhibit. The purpose of Sub-question 2 was to compare these intentions to visitors' actual self-reported environmentally responsible behaviors several weeks after their

visit. Sub-question 3 was included to illuminate what visitors perceived as the reasons for the differences between their intentions and behaviors. Knowledge of these perceived barriers could potentially improve the design of future exhibits. Sub-question 4 attempted to determine the elements of the exhibit's design (e.g., text panels, manipulatives, visuals, docents) that seemed to have an influence on visitor intentions or behaviors. This information was also helpful in making suggestions for future exhibits. As what is learned in an exhibit is very often different from what was intended by its designers (Falk, 2005), Sub-question 5 attempted to discover how visitors' interpretations of the exhibit's messages might have influenced their behaviors or intentions.

1.4 Research Setting

According to their website (www.calacademy.org), the mission of the California Academy of Sciences in San Francisco, CA is "to explore, explain and protect the natural world." In line with that mission, the Academy is driven by two main questions: "How has life evolved, and how can it be sustained?" Although this museum has much in common with other U.S. informal science learning environments, it is unique in its own level of commitment to the environment. In addition to suggesting that visitors adopt more environmentally responsible behaviors, the museum strives to set an example for the community.

The Academy is one of the few buildings in the world to have achieved a Platinum level of Leadership in Energy and Environmental Design (LEED) certification. The LEED certification program was developed in 2000 by the U.S. Green Building Council (USGBC) to measure how well a building or community "performs across all the metrics that matter most: energy savings, water efficiency, CO₂ reduction, improved indoor environmental quality,

stewardship of resources and sensitivity to their impacts” (USGBC, 2009). A platinum level of certification means the Academy has achieved 80 or more out of a possible 100 points on the rating scale developed by the USGBC. The innovations leading to this award included automatic skylights to cool the building and provide natural lighting, wall insulation made of recycled blue jeans scraps, and a two and a half acre living roof which is home to almost two million plants. On September 27, 2011, the California Academy of Sciences was awarded its second Platinum LEED award in three years, making it the world’s first Double Platinum museum (“What’s New at the Academy”, 2011).

The Academy opened the *Altered State: Climate Change in California* exhibit in September 2008 after a research study found a significant number of Americans continue to have misconceptions about climate change. The exhibit “uses California as a case study to explore the science of climate change, the effects we might expect to see in our own backyard, and the steps that can be taken to mitigate these dramatic changes” (Stone, 2008). A variety of elements, including text panels, images, videos, manipulatives, live animals, and preserved specimens help to explain to visitors how climate change has both local and global effects. Several areas of the exhibit suggest environmental actions people can take to combat climate change. There are also a number of panels and manipulatives which encourage visitors to share their own solutions.

A summative evaluation was conducted in 2009 to determine how successfully the exhibit’s messages were being conveyed to the public. During the evaluation, over 100 visitors were observed and interviewed to determine where they spent their time in the exhibit and what messages they took away from the experience (Randi Korn & Associates, Inc., 2009). Although the study found the exhibit was successful overall, certain areas seemed to be

confusing to visitors. Several modifications were made as a result of the 2009 evaluation. For example, the exhibit was reorganized into three modules called Your Changing World: Home, Your Changing World: California, and Your Changing World: Earth. The exhibit has not been re-evaluated since the modifications were made.

1.5 Reflexivity Statement

Along with many other contemporaries in education, my beliefs about knowledge construction align with the theory of human constructivism (Novak, 1977). Knowledge is something meaningfully constructed by learners as they attempt to connect newly encountered concepts to their existing cognitive structures. According to Novak, educators can only act as facilitators to this highly personal process. Further, learning in informal environments is meaningful, but often very different from the expectations of the staff (Falk, 2005; Falk & Dierking, 2000; Hein, 1995). I believe improving education, especially in informal settings, requires us to consider the complex, highly individualized nature of human learning.

Working in nature centers and zoos for a number of years has afforded me many opportunities to think about how informal exhibits and programs might impact learning. Those experiences likely influenced my decision to study this topic. I do not believe a “magic bullet” exists for increasing learning in informal settings. The nature of free-choice learning and the unique experiences and knowledge of each learner makes it nearly impossible to predict what people will take away from a learning experience (Falk, 2005). Still, I think informal education is vitally important and can significantly contribute to the learning that occurs throughout a lifetime. Informal education sites can, and should, continue to improve.

My own efforts to be environmentally responsible likely colored my perceptions during this study. I personally choose to recycle, avoid disposable packaging, and shop at

second-hand stores. I turn off unused electronics and rarely eat meat. However, I can also relate to those who want to be more environmentally conscious but feel they cannot. I have had personal experiences with the practical and situational barriers that can prevent change. For example, I often find it difficult to regularly compost, buy local produce, or use public transportation.

I feel that visitors' experiences and insights are critical to enhancing informal learning environments. Yet a review of the literature on environmentally responsible behaviors shows that few studies have given learners opportunities to share their own understandings. Almost all of the existing studies about what influences intentions or behaviors related to the environment were conducted using quantitative methods. My views of learning and meaning-making suggest that these conversations are vitally important to have with learners. For this reason, I approached this study from a qualitative standpoint.

My personal experiences as both a teacher and a student helped to prepare me for this study. As a classroom teacher and an informal educator, I have seen the possibilities for using diverse educational environments to influence pro-environmental behavior. In my graduate studies, several qualitative research classes afforded me opportunities to practice my observational, interviewing, and coding skills. These experiences certainly influenced the questions I asked and the way I interpreted my data.

1.6 Glossary

Attitude: a person's favorable or unfavorable feelings with regard to a particular object or idea

Barrier: an obstacle or impediment; in this paper, an obstacle to changing one's behavior

Behavior: an observable event consisting of an action, a target, a context, and a time frame

Case Study: an in-depth investigation of a phenomenon within its real-life context

Environmental Action Strategy: an approach or tactic for solving an environmental issue

Environmental Literacy: the capacity of a person to perceive the health of environmental systems and take appropriate action to maintain, restore, or improve them

Environmentally Responsible Behavior: an action performed by either an individual or a group which maintains or improves the environment for the well-being of society

Exhibit: an object or set of objects on public display; can also be used to refer to an exhibition

Free-choice Learning: self-directed and voluntary learning undertaken for personal fulfillment

Informal Science Learning Environment: an educationally-focused, non-school setting which exposes people to science concepts in a semi-structured or unstructured way

Intention: a person's level of readiness or willingness to engage in a particular behavior

Interactive: a learning tool which "reacts" to a person's actions

Internal Locus of Control: the extent to which an individual believes she has the ability to bring about change through her own behavior

Manipulative: a hands-on object meant to be used as an aid to learning

Non-formal Education Program: a non-school program guided by a knowledgeable facilitator who selects specific content to share with participants over a pre-determined period of time

Perceived Behavioral Control: the extent to which a person believes she is capable of performing a specific behavior; see also "self-efficacy"

Perceived Norms: the perception of the social pressure to perform a certain behavior, resulting from a person's beliefs about the approval and the actions of others

Personal Responsibility: a feeling of personal obligation, investment, or sense of duty

Self-efficacy: a person's level of belief that he has the ability to perform certain actions; see also "perceived behavioral control"

1.7 Frequently Used Acronyms

EAS - Environmental Action Strategies

EE - Environmental Education

EPA - Environmental Protection Agency

ERB - Environmentally Responsible Behavior

ISLE - Informal Science Learning Environment

NAAEE - North American Association for Environmental Education

NEEAC - National Environmental Education Advisory Council

NEETF - National Environmental Education and Training Foundation

UNESCO - United Nations Educational, Scientific, and Cultural Organization

TRA - Theory of Reasoned Action

TPB - Theory of Planned Behavior

2. LITERATURE REVIEW

This literature review begins with an overview of the events which helped to shape the field of environmental education, as well as an explanation of the concepts of environmental literacy and environmentally responsible behaviors. This is followed by a discussion of the unique challenges faced by environmental education in the 21st century. The factors believed to impact behavior and common theoretical models of behavior change are also discussed. Research which has attempted to connect formal education and behavior is reviewed, along with studies which have been completed at informal science education sites. The main purpose of this literature review is to discuss the progression of formal and informal environmental education in the United States, specifically as it relates to environmentally responsible behavior. The articles selected for inclusion represent a significant portion of the total body of literature in this field; however, this review does not claim to be exhaustive.

2.1 Environmental Education

Environmental education (EE) emerged as a new discipline during the middle of the 20th century as a result of growing concerns about environmental issues, such as endangered species, air and water pollution, and the availability of energy and resources for an increasing world population. Books such as Rachel Carson's *Silent Spring* (1962), which warned of the dangers of pesticide use, began to increase environmental awareness and concerns about human health. On April 22, 1970, the first Earth Day was celebrated by almost 2 million Americans. This event united and energized pro-environmental groups and led to the creation of the United States Environmental Protection Agency (EPA) as well as the passing of the Clean Air, Clean Water, and Endangered Species Acts (Earth Day Network, n.d.).

In addition to political reforms, the environmentalism movement of the 1960s and 70s strove to increase the environmental awareness and knowledge of American students through environmental education. The field grew out of many other disciplines, including conservation education, nature study, resource use education, outdoor education, resource management education, and the progressive education movement (Archie & McCrae, 1996; Disinger, 1983; Roth, 1992). By the late 1960s, there was enough interest in EE as a distinct entity to warrant definitional statements for the field (Disinger, 1983). One of the most widely accepted early definitions for EE came from the University of Michigan faculty and graduate students in 1969:

Environmental education is aimed at producing a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work together toward their solution. (Stapp et al., 1969, p. 31)

However, from the beginning there was very little agreement about the goals and purposes of EE or the most effective and appropriate methods for teaching about the environment.

Disinger (1998) identified several philosophical standpoints regarding the environment, ranging from the view that it can provide unlimited resources and absorb unlimited amounts of waste (Cornucopian) to the idea that human impacts should be effectively eliminated from the natural world (Preservationist). Between these standpoints lies a continuum of perspectives, including one which endorses sustainable management of the environment and places equal emphasis on environmental quality and human needs (Utilitarian Conservationist). According to Disinger, disagreements in the EE field were partly the result of these differing worldviews regarding the relationship between humans and the natural world.

Another reason for early disagreements about the purpose of EE may have stemmed from the inability of American society to define a purpose for its educational systems in general (Disinger, 1998). Some have argued that education is a method for transmitting existing cultural and social norms to the next generation. Others see it as a means to bring about political, social, or cultural changes. A number of professionals in the EE field have argued that the primary purpose of all types of education is to promote desirable behavior (see Culen, 1998; Hungerford & Volk, 1990).

A third reason may have been the number of different fields influencing environmental education. According to Disinger (1983), there was initially disagreement over whether EE was essentially a continuation of the conservation education movement or an attempt to expand outdoor education to include other fields such as resource management education. As early environmental educators likely had different personal worldviews about the environment, differing opinions about the purpose of education, and different ideas about the scope of EE, developing a clear direction for the field quickly became critical.

Efforts to identify potential goals and objectives for EE, as well as sets of key characteristics and guiding principles, began in the 1970s (McBeth & Volk, 2010). In 1975, United Nations Educational, Scientific, and Cultural Organization (UNESCO) and the United Nations Environmental Program (UNEP) held a workshop in Belgrade, Yugoslavia to discuss global EE priorities and strategies. For many, this workshop marked the beginning of the environmental education movement (Volk & McBeth, 1998). The two main outcomes of this workshop were a statement of purpose for EE, referred to as the Belgrade Charter, and a detailed list of recommendations for implementing the goals and objectives outlined in the Charter (Aldrich, Blackburn & Abel, 1977).

Following the UNESCO/UNEP workshop, a series of regional seminars occurred in which nations were able to review and modify the Belgrade Charter's recommendations. Canada and the United States participated in the North American Regional Seminar (NARS) on Environmental Education in 1976. NARS participants attempted to identify priorities and strategies for EE in North America. Specifically, the seminar focused on better defining three areas of North America's EE programs: (1) key target audiences, (2) critical content issues, and (3) appropriate implementation strategies (Aldrich et al., 1977). In addition to clarifying EE for the United States and Canada, NARS also generated a report for UNESCO/UNEP's Tbilisi Intergovernmental Conference on Environmental Education.

The Tbilisi Conference of 1977 was an opportunity for representatives from 66 nations to discuss global environmental problems and the importance of developing EE programs both nationally and internationally. The major outcome of this conference was a series of recommendations summarized within the Tbilisi Declaration. The Declaration stated that EE should foster awareness and concern about economic, social, political and ecological interdependence, provide opportunities for people to acquire the knowledge, attitudes, and skills needed to protect the environment, and create new patterns of environmental behavior within individuals, groups, and society (UNESCO, 1978; Volk & McBeth, 1998).

In addition to these goals, the Tbilisi Declaration also identified categories from which to generate objectives for EE: (1) an awareness and sensitivity to the environment and its problems, (2) knowledge of the environment and its problems, (3) an attitude of concern for the environment a motivation for actively participating in environmental protection or improvement, (4) skills for identifying and solving complex environmental problems, and (5)

active participation in working toward resolutions of environmental problems (UNESCO, 1978; Volk & McBeth, 1998).

Thirdly, the Declaration offered some guiding principles for EE. Tbilisi Conference participants suggested learners should be given opportunities to examine environmental issues from local, national, regional and international points of view, and should be allowed to help plan their own learning experiences. Further, they stated that EE should be taught in a holistic, interdisciplinary manner to emphasize the complexity of environmental problems and should utilize “diverse learning environments and a broad array of educational approaches” stressing practical and first-hand experiences (UNESCO, 1978, p. 27).

The Tbilisi objectives heavily influenced early efforts to develop curriculum and instructional strategies in EE. For example, Hungerford, Peyton, and Wilke (1980) used the Tbilisi Declaration to generate a superordinate goal for the field. They argued that an EE curriculum should:

...aid citizens in becoming environmentally knowledgeable and above all, skilled and dedicated citizens who are willing to work, individually and collectively, toward achieving and/or maintaining a dynamic equilibrium between quality of life and quality of the environment. (p. 43)

Hungerford et al. also proposed several goals within this superordinate goal, each one accompanied by specific objectives and ideas for EE curriculum and instruction. These goals included: providing the learner with a sufficient foundation of knowledge to make ecologically sound decisions, developing the learner’s awareness of the relationship between human life and the environment, nurturing the knowledge and skills required to investigate issues and explore solutions, and developing the skills needed to take appropriate actions.

2.2 Environmental Literacy

One of the most commonly identified goals for EE is to increase a learner's level of environmental literacy. The term "environmental literacy" began to appear in the EE literature of the 1970s. Charles Roth first used the term in 1969, in response to media statements about "environmental illiterates" who were polluting the environment (Roth, 1992). The phrase was quickly adopted by many. According to Disinger (1983), Richard Nixon even used the term in his August 1970 Environmental Message to Congress.

Though it became increasingly common over the next 20 years to state that the purpose of EE was to promote environmental literacy, efforts to clarify the term's meaning did not begin until the early 1990s. One of the most well-known definitions was proposed by Roth (1992). He stated:

Environmental literacy is the capacity to perceive and interpret the relative health of environmental systems and to take appropriate action to maintain, restore, or improve the health of those systems. Environmental literacy is a continuum of competencies ranging from zero competency to very high competency that can be functionally divided into three working levels - nominal, functional, and operational environmental literacy. (p. 8)

At each level, a person's awareness, concern, understanding, and action relative to the environment increase. For example, individuals with a nominal level of environmental literacy are able to define basic terms, have a basic knowledge of natural systems, show sensitivity toward the environment, and demonstrate respect and concern for nature. People with the highest level of environmental literacy (operational environmental literacy) possess an in-depth knowledge of natural systems, can evaluate the impacts and consequences of their actions, have a strong sense of personal responsibility, and are invested in taking action to sustain a healthy environment (Roth, 1992).

Marcinkowski (1991) described environmental literacy as a combination of: (1) awareness and sensitivity toward the environment, (2) an attitude of respect and concern, (3) knowledge and understanding of natural and social systems, (4) an understanding of environmental problems and issues, (5) the skills required to analyze, synthesize, and evaluate information about environmental problems/issues, (6) a sense of personal investment, responsibility, and motivation to work toward their resolution, (7) a knowledge of available solutions and strategies, (8) the skills to develop, implement, and evaluate these solutions, and (9) active involvement in working toward the resolution of environmentally-related problems and issues. Roth's and Marcinkowski's definitions have many similarities. However, Marcinkowski focused more heavily on the development of relevant skills.

Other conceptions of environmental literacy exist. For example, Stables and Bishop (2001) explored the idea of the environment as a fluid, socially-constructed text. They described becoming environmentally literate as the development of the ability to "read" this text. Further, they stated a broad view of environmental literacy recognizes that there are multiple correct ways to make sense of the environment, and ideas about the environment will differ between individuals, cultures, and social groups.

Stables (1998) originally discussed three types of environmental literacy: functional, cultural, and critical. The first type, functional environmental literacy, refers to the ability to understand and connect ecological concepts. According to Stables, the foundation provided by functional literacy is necessary for the development of cultural and critical environmental literacy.

Cultural environmental literacy refers to the ability to recognize the significance of natural objects which have been ascribed a greater value by a society. For example, culturally

literate individuals understand why the bald eagle holds a different status in America than other birds of prey. The third type, critical environmental literacy, enables the learner to act. The knowledge provided by functional literacy and the empowerment of cultural literacy provide support for these actions (Stables, 1998). Although Stables' view of literacy seems to differ from others in the EE field, Morrone, Mancl, & Carr (2001) asserted that these ideas align with the goals for environmental education identified by Hungerford et al. (1980).

Despite recent arguments that a common definition still does not exist, the EE field seems to have become increasingly aligned with certain ideas about environmental literacy. Today, most of the well-known EE frameworks tend to define environmental literacy as a person's level of competence with regards to environmental awareness, knowledge, attitudes, skills, and behavior (e.g., Marcinkowski, 1991; Roth, 1984, 1992; Simmons, 1995; UNESCO, 1978; Volk & McBeth, 1998; Wilke, 1995).

Multiple frameworks for addressing environmental literacy began to appear in the 1990s (McBeth & Volk, 2010). One of the most well-known attempts to impact environmental literacy was undertaken by the North American Association for Environmental Education (NAAEE). The NAAEE first began its National Project for Excellence in Environmental Education in an attempt to keep EE from being neglected by the national standards movement (McCrae, 2010). Early in the Project, four working papers were published which discussed the need for EE standards related to student performance, content, and educator performance. These papers used the 1975 Belgrade Charter and the 1977 Tbilisi Declaration as environmental education "blueprints" (Simmons, 1995).

In addition to the early frameworks of the 1970s, the NAAEE Project consulted dozens of other documents, such as EE frameworks and models, criteria development

projects, goals and frameworks for curriculum development, and state curriculum standards (Simmons, 1995; Volk & McBeth, 1998). The resulting voluntary standards combined the goals, objectives, and principles identified in these documents, and then expanded on them to form a broad framework for EE and environmental literacy. These standards were called the NAAEE Guidelines, and were meant to provide a direction for environmental education in America by outlining the core components of EE and providing a metric for evaluating the quality of EE programs (Simmons, 1995). According to Volk and McBeth (1998), the categories represented contemporary thinking about the attributes an environmentally literate person would possess. The full descriptions of the seven framework categories can be found in Appendix A.

Today, the NAAEE National Project for Excellence in EE offers five sets of Guidelines including performance expectations for grades 4, 8, and 12, recommendations for classroom instruction and informal EE programs, and suggestions for pre-service and in-service professional development for environmental educators (NAAEE Staff & Simmons, 2010/2011). These Guidelines continue to inform many EE programs and provide a direction for achieving environmental literacy.

Around the same time that professional organizations such as NAAEE started to develop environmental literacy frameworks, the United States government began its own attempts to improve EE. In 1990, Congress passed the National Environmental Education Act, charging the United States Environmental Protection Agency (EPA) with providing national leadership for EE as part of its mission to improve and protect human health and the environment (Potter, 2010). Specifically, the Act called for the EPA to work with local, state, non-profit, and private sector educational and environmental organizations to increase the

public's understanding of the environment and improve their awareness of environmental problems (EPA, 2009). The Act also gave the EPA the ability to award funding related to EE, established the Office of Environmental Education, and charged the EPA with the development of awards for outstanding contributions to the field. Additionally, the Act established the National Environmental Education Advisory Council and the National Environmental Education and Training Foundation.

The National Environmental Education Advisory Council (NEEAC) consists of representatives from outside of the federal government who provide the EPA with advice on EE and the needs of schools, universities, state departments, and educational organizations (EPA, 2011). In 2005, NEEAC called for a national increase in environmental literacy in its Report to Congress, citing the need for the American public to have the ability to analyze environmental issues and make informed decisions. NEEAC also developed eight recommendations to meet this need: (1) update the National Environmental Education Act, (2) broaden the audience and leadership of EE field, (3) improve EE materials and programs, (4) develop a framework to measure the effectiveness of EE, (5) support long-term research, (6) establish a grant program to enable delivery of EE programs, (7) develop EE professional development programs for formal and non-formal educators, and (8) build public understanding of the value of EE and increase the number of people pursuing environmental careers (NEEAC, 2005).

The National Environmental Education and Training Foundation (NEETF) was founded in 1990 as a complementary organization to the EPA. NEETF's main goals involve offering quality EE programs to schools, the adult public, health professionals, and business managers. Its status as a private non-profit organization gives NEETF the ability to leverage

funds normally unavailable to government agencies (National Environmental Education Foundation, 2008). NEETF has annually commissioned Roper Starch Worldwide surveys since 1995 to assess the American public's attitudes and behaviors surrounding environmental issues (Environmental Education and Training Partnership, 1999).

Not long after NEETF began the Roper surveys, Volk and McBeth (1998) attempted to determine the state of environmental literacy in the United States. They referenced over 30 studies completed between 1978 and 1995 that assessed components of environmental literacy. They found all measures of literacy ranged from low to moderate across all of the studies. Specifically, most aspects of environmental knowledge tended to be low; in particular, ecological and socio-political knowledge were consistently low. Environmentally responsible behavior also tended to be low. Affective dimensions of environmental literacy averaged in the moderate range. Volk and McBeth concluded that EE appeared to be far from its goal of achieving environmental literacy, and very little was actually known about environmental literacy in 1998 because of the lack of consistency in the research. They recommended the development of more consistent measures of environmental literacy and the establishment of a baseline level of environmental literacy in the United States.

In 2005, Coyle reported on the status of environmental literacy in America using the consolidated results of the NEETF/Roper surveys administered between 1995 and 2005. He found adult Americans consistently answered fewer than 25% of questions correctly on these surveys; further, the data suggested only 1-2% of adults have sufficient knowledge and skills to be considered environmentally literate. Additionally, Coyle (2005) reported that overall awareness of simple environmental topics and one-step environmental issues was reasonably high, but there was a considerable drop-off in the level of public comprehension about more

complex, multiple-step environmental issues or processes. Coyle suggested that Americans may have a difficult time understanding complex causal relationships in the natural world (a “causal disconnect”), and may not always understand what the scientific community is trying to say (a “terminology disconnect”).

Environmental literacy studies have also been conducted with school-age children in the United States (e.g., Bogan & Kromrey, 1996; Culen & Mony, 2003; McBeth & Volk, 2010; Wilke, 1995). This research has found like adults, American students tend to have a positive attitude toward the environment but a low level of knowledge of environmental action strategies. American children also value behaviors which are positive for the environment, but tend not to participate in these behaviors themselves. For example, Bogan and Kromrey (1996) reported that Florida high school students indicated concern for maintaining environmental quality, but did not properly connect this concern to environmental policy development or personal behaviors. Similarly, Culen and Money (2003) found EE curricular materials were able to increase ecological knowledge in Florida 4-Hers, but were ineffective at increasing the number of pro-environmental behaviors performed by members of the youth group.

In 2010, McBeth and Volk attempted to establish a baseline measure of literacy in U.S. middle school students using the Middle School Environmental Literacy Survey. Specifically, they assessed multiple aspects of environmental literacy, including ecological knowledge, environmental sensitivity, environmental emotion (attitudes), issue and action skills, verbal commitment (willingness to act), and actual commitment (behavior). They discovered that 8th grade students outscored 6th graders on measures of ecological knowledge and cognitive skills, but that 6th graders had more positive feelings about the environment,

greater willingness to take positive action, and higher levels of participation in environmentally responsible behaviors. These results suggest that either American middle school students are not exposed to enough EE, or existing EE curricular materials are only effective at impacting some aspects of literacy.

It is clear that EE continues to struggle to increase environmental literacy in the United States. David (1974) related the development of environmental literacy to learning a new language; just as a student may pass a foreign language class, yet still be unable to effectively communicate in that language, a person may emerge from an EE course still lacking environmental literacy. Studies suggest Americans are still not “fluent” in the language of EE.

2.3 Environmental Education in the 21st Century

Environmental education has a critical role to play in preparing Americans to meet the challenges of the next century (Hungerford, 2010; Janes, 2010; Marcinkowski, 2010; Potter, 2010; Short, 2010; Strife, 2010), especially as the connection between social and environmental problems continues to grow. For example, Wilkins (1993) argued that climate change is more of a social phenomenon than an environmental one because it is driven by political and economic choices. The sustainable development movement is an effort to meet the societal needs of the present generation without compromising the environment for future generations (Marcinkowski, 2010). Similarly, the green movement is an attempt to respond to environmental concerns by emphasizing the social benefits of environmentally responsible behaviors (Strife, 2010). Few of the environmental issues of the 21st century will have simple solutions.

The subject of climate change poses some unique challenges to the EE community (Marcinkowski, 2010). Like other contemporary environmental issues,

...climate change presents a problem that is beyond the capability of the physical sciences alone to address. The conditions that brought us climate change, as well as the conditions surrounding future options for dealing with it, are embedded in socioeconomic structures and value systems... that are highly resistant to change. (Trumbo & Shanahan, 2000, p. 200)

However, unlike sustainable development and the green movement, climate change may pose additional challenges for environmental educators because of the controversy that is often associated with the topic.

Mintz (1995) asserted that issues and controversies are different, as an issue raises questions about values (is this moral?) but a controversy raises questions about facts (is this accurate?) Whether or not human activity has contributed to climate change would be a “controversy” discussion. Deciding what actions to take in response to climate change would be part of an “issue” discussion. Climate change is rarely controversial within the scientific community. As explained by the National Research Council (2011):

Although the scientific process is always open to new ideas and results, the fundamental causes and consequences of climate change have been established by many years of scientific research, are supported by many different lines of evidence, and have stood firm in the face of careful examination, repeated testing, and the rigorous evaluation of alternative theories and explanations. (p. 15)

Despite the general consensus among scientists, climate change remains a controversy for some. Where this comes from is not entirely clear, but the U.S. news media may be partly responsible.

According to Fortner et al. (2000), the media tends to have a greater impact on public attitudes and behavior when an environmental issue is perceived to be uncertain.

Unfortunately, the media also tends to oversimplify or mischaracterize environmental issues

(Coyle, 2005). Bell (1994) found numerous examples of exaggeration or confusion in media reports on climate change. Zehr (2000) claimed that journalists introduce uncertainty into discussions of climate change to create more dramatic and interesting copy. Others have suggested that the tentative nature of science and the unwillingness of scientists to speak in absolutes about climate change may be misinterpreted by reporters as uncertainty (Fortner et al., 2000).

Trumbo and Swanagan (2000) asserted that the media helps the public to understand “obscure yet potentially threatening situations in terms of their everyday lives” (p. 201), and that this may facilitate the public’s dependence on the media for making sense of environmental issues. The public’s reliance on the media may explain why the term “global warming”, which is heavily favored by media sources, evokes significantly more concern than the term “climate change”, which is preferred by scientists and policy makers (Whitmarsh, 2009). Interestingly, though, Whitmarsh also reported that even though the general public receives most of their knowledge about climate change from media sources, they consider the scientific community to be a more trusted source of information.

Informal science learning environments are also trusted sources of science information, including information about environmental issues and controversies. Mintz (1995) asserted that science museums can contribute to “issues education” because they serve a broad cross-section of the population, are perceived as neutral providers of reliable information, and provide opportunities for multiple perspectives to be heard in a safe, non-judgmental setting. Mazda (2004) stated that controversial topics should be promoted in museums, as they more accurately represent the nature of science and raise awareness of the different positions within an issue. A number of controversial science topics have been

successfully presented to the public in museum settings (Boyd, 1999; Delicado, 2009; Macdonald & Silverstone, 1992; Yaneva, Rabesandratana, & Greiner, 2009).

High-quality environmental education is needed to prepare the general public to deal with contemporary environmental issues such as climate change. As Bord, O'Connor, and Fisher (2000) concluded:

Effective public education on global warming, and other environmental threats, is essential. Occasional media coverage of environmental disasters might heighten or maintain general levels of concern, but they will not make Americans good environmental citizens. (p. 216)

Like the news media, informal learning environments have the ability to reach a larger and more diverse audience than school-based EE programs. However, the public may trust museums and other informal environments more than the media to provide accurate scientific information. A detailed discussion of informal science learning environments and how they can potentially contribute to the environmental literacy of Americans is presented in section 2.7 of this review.

2.4 Environmentally Responsible Behaviors

Sia, Hungerford, and Tomera (1985/1986) stated that until a person consistently behaves in a way that is environmentally responsible, he has not become fully environmentally literate; in other words, that environmental literacy is synonymous with pro-environmental action. Environmentally responsible behaviors (ERBs) are defined as actions taken by individuals or groups which positively impact the environment, or actions which maintain the environment for the well-being and survival of a whole society (Hsu & Roth, 1998). One difficulty with defining ERBs is that “positive impact” is not always a static concept. At different times or in different locations, the same behaviors can impact the environment in very different ways (Monroe, 2003). Other phrases which have been used in

the literature include: environmental behaviors, conservation behaviors, pro-environmental behaviors, pro-ecological behaviors, environmentally responsible citizenship behaviors, responsible environmental behaviors, environmentally responsible activities, environmental actions, responsible environmental actions, environmentally-responsible actions, and environmental problem solving.

The Tbilisi Declaration identified the creation of new behavior patterns as a major objective of EE (UNESCO, 1978). Since then, many have emphasized the importance of environmentally responsible behaviors in discussions of EE or definitions of environmental literacy (e.g., Boerschig & DeYoung, 1993; Coyle, 2005; Heimlich & Ardoin, 2008; Hines, Hungerford, & Tomera, 1986/1987; Hsu, 2004; Hungerford et al., 1980; Hungerford & Volk, 1990; Hwang, Kim, & Jeng, 2000; Marcinkowski, 1991; McBeth & Volk, 2010; Newhouse, 1990; Short, 2010; Sia et al., 1985/1986; Simmons, 1995; Sivek & Hungerford, 1989/1990; Roth, 1992; Volk & McBeth, 1998; Wilke, 1995). Hungerford and Volk (1990) argued that shaping human behavior is the ultimate aim of any type of education, as societies establish educational systems to teach their citizens appropriate or desirable ways of behaving. However, they went on to say that the citizenship behavior implied by the Tbilisi objectives “demands an educational thrust that goes beyond ‘basic’ education in its traditional sense” (Hungerford & Volk, 1990, p. 9). Similarly, Short (2010) stated that the goal of all education is action, and the goal of EE is to encourage action “which maintains or improves conditions necessary for ecosystem stability, biological diversity, and abundance” (p. 18).

ERBs are the human behaviors aimed at solving environmental problems or expressing concern for the environment (Marcinkowski, 1998). Many examples of these types of behaviors have been offered in the literature. Stapp et al. (1969) suggested that

environmentally responsible citizens can help to create sound environmental policies by voting, electing representatives, asking informed questions, serving on committees, and supporting pro-environmental legislation. Borden (1984/1985) labeled certain personal activities environmentally responsible, such as recycling, conserving energy, participating in community projects, and consumer boycotting. Similarly, Roth (1992) identified specific actions an environmentally literate person could take to correct “imbalances” in the environment: (1) making consumer and work practices ecologically sound, (2) expressing concerns to appropriate officials, (3) suggesting, writing, or supporting appropriate legislation, (4) initiating and/or participating in group action and encouraging others to do so, (5) supporting organizations with time and/or money.

Hungerford and Peyton (1980) organized different types of environmental action into five distinct categories. First, *persuasion* involves using personal and interpersonal strategies to address environmental problems or issues, such as petitions, letter writing, and informal discussions with others. Actions related to *consumerism*, such as choosing to buy goods made with recyclable materials or less packaging, can modify the behavior of business or industry. *Political action*, or persuading governmental leaders and agencies, may take the form of talking to officials, lobbying, or running for office. Reporting violations, patrolling, testifying, and other actions related to the creation and enforcement of environmental regulations and legislation fall into the fourth category, *legal action*. Finally, *ecomangement*, or physical action to maintain ecosystems, includes actions such as taking public transportation, recycling, and eating less meat. Interactions between these five types of actions form a sixth category (Hungerford & Peyton, 1980). Others have proposed alternate categories of environmental action which may be equally valid (e.g., Monroe, 2003; Smith-Sebasto, 1992;

Stern, 2000). However, the categories developed by Hungerford and Peyton have been incorporated into EE frameworks such as the NAAEE Guidelines for Excellence and the Environmental Education Literacy Consortium's 1994 Environmental Literacy Framework (Simmons, 1995; Volk & McBeth, 1998).

In addition to identifying types of environmentally responsible behaviors, Hungerford and Peyton (1980) also proposed a set of questions which individual or groups would likely ask themselves prior to undertaking any environmental actions. The authors suggested these "action analysis criteria" questions should be made available to EE educators and students in order to "increase the sophistication with which actions are taken" (Hungerford & Peyton, 1980, p. 152). This list was one of the first efforts to identify factors which would affect the willingness and/or ability to take environmental actions. Since then, many have attempted to determine how to identify and address the variables which impact ERBs.

Research into environmental behaviors increased significantly in the 1970s and 1980s. Empirical studies on the variables impacting environmentally responsible behaviors appeared in a number of different academic disciplines, including education, psychology, sociology, political science, and business, but lack of communication between these fields made it difficult to form a coherent picture of the factors affecting ERBs (Hines et al., 1986/1987).

In an effort to synthesize the existing research findings, Hines (1984) performed a meta-analysis of 128 studies published between 1971 and 1985. She analyzed the impact of cognitive, psycho-social, and demographic variables on ERBs, and investigated a group of experimental studies which used classroom strategies or behavioral intervention approaches to encourage pro-environmental behavior. Hines et al. (1986/1987) reported the results of this meta-analysis, which found cognitive variables (including knowledge of environmental

issues) and psycho-social variables (such as attitude, locus of control, verbal commitment, and personal responsibility) were positively correlated with responsible environmental behavior, but demographic variables had little or no relationship to ERBs. Further, programs which identified relevant environmental issues and focused on developing the necessary skills for solving these issues were more likely to influence behavior.

In the last 30 years, many researchers have explored the variables which might affect ERBs (e.g., Boerschig & DeYoung 1993; Borden, 1984/1985; Cottrell & Graefe, 1997; Heimlich & Ardoin, 2008; Hsu & Roth, 1999; Hungerford & Volk, 1990; Hwang et al., 2000; Marcinkowski, 1989; Newhouse, 1990; Short, 2010; Sia et al, 1985/1986; Siemer & Knuth, 2001; Sivek & Hungerford, 1989/1990). Most of these studies were undertaken out of a desire to both predict and change behavior. As Ajzen and Fishbein (1980) pointed out, “although prediction is possible with little or no understanding of the factors that cause a behavior, some degree of understanding is necessary for producing change” (p. 4).

In one classic study, Sia, Hungerford, and Tomera (1985/1986) tested the predictive value of eight variables on ERBs: (1) environmental sensitivity, (2) perceived knowledge of environmental action strategies, (3) perceived skill in using environmental action strategies, (4) individual locus of control, (5) group locus of control, (6) psychological sex role classification, (7) belief in/attitude toward pollution, and (8) belief in/attitude toward technology. They reported that environmental sensitivity combined with perceived knowledge of and perceived skill in using environmental action strategies (EAS) accounted for almost 50% of the variance in participants’ environmental behavior scores. When this study was repeated using different populations, environmental sensitivity and perceived skill in using EAS were found to be the strongest predictors of ERBs (Sivek & Hungerford, 1989/1990). A

later study which followed the same procedure found perceived knowledge of and perceived skill in using EAS to be the most significant predictors of behavior (Marcinkowski, 1989).

In comparing these findings, Marcinkowski (1998) found the five main variables which impacted actual and predicted behavior scores across all three studies were: individual locus of control, group locus of control, knowledge of EAS, skill in using EAS, and environmental sensitivity. These five predictor variables have been used in various models of behavior change and incorporated into numerous environmental literacy frameworks, such as the National Environmental Literacy Assessment Project and the NAAEE Guidelines for Excellence (Simmons, 1995; Wilke, 1995).

Still, a wide variety of ERBs frameworks exist, only some of which align with the variables identified by Sia et al. (1985/1986). For example, Kollmuss and Agyeman (2002) chose to categorize factors as demographic, internal, or external. They identified gender and years of education as two demographic factors believed to impact attitudes or behaviors. Variables such as economic, social, and cultural factors were considered external factors. Internal factors included motivation, knowledge, values, responsibilities, and priorities.

2.5 Models of Behavior Change

It was traditionally believed that increasing a learner's environmental knowledge would increase awareness, leading to a change in attitude which eventually would motivate the learner to perform pro-environmental behaviors. This explanation for behavior change is widely known as the knowledge-attitude-behavior (KAB) model. Many in the EE field have critiqued the classic KAB model (e.g., Hines et al., 1986/1987; Hungerford & Volk, 1990; Marcinkowski, 1998; McKenzie-Mohr, Nemiroff, Beers, & Desmarais, 1995; Ramsey & Rickson, 1976; Sia et al., 1985/1986).

One of the main criticisms of this model is that increasing knowledge may not lead to changes in behavior. According to Hungerford & Volk (1990), environmental behavior research has been unable to demonstrate that making a person more knowledgeable about the environment results in that person demonstrating more ERBs. More recently, Ajzen, Joyce, Sheikh, and Cote (2011) found “knowledge about the environment was virtually unrelated to general attitudes regarding the environment, and it had no influence... with respect to engaging in energy-saving behaviors” (p. 107). Similarly, Barr (2003) reported that environmental awareness campaigns meant to increase public knowledge were ineffective at changing recycling and waste reduction behavior. The results of McBeth and Volk’s 2010 environmental literacy survey of middle school students also suggested that increased environmental knowledge does not correlate with changes in environmental behavior.

However, there is support for some of the relationships identified in the KAB model. Although knowledge may not influence behavior directly, certain types of knowledge may promote environmental action. Some kinds of knowledge may be more closely linked to ERBs, such as knowledge of environmental issues, the causes of these issues, and strategies for addressing them (Jensen, 2002). Others have argued that knowledge of environmental action strategies is an important component of behavior change (e.g., Hines et al., 1986/1987; Marcinkowski, 1989; Sia et al., 1985/1986).

Ramsey and Rickson (1976) found increasing knowledge led to moderate changes in attitude. Hwang et al. (2000) reported that knowledge directly affected their study participants’ attitudes, and attitudes directly affected the intention to act in an environmentally responsible way. According to Hines et al. (1986/1987), multiple studies have reported a moderate correlation between attitude and environmental behavior, especially in studies using

revealed (or actual) behavior rather than self-reported behavior. In comparing groups who engaged in ERBs with either low, moderate, or high frequency, Borden (1984/1985) found attitude about environmental issues appeared to be an important underlying motivation for behavior.

There are challenges to understanding the relationship between attitude and behavior. Kollmuss and Agyeman (2002) credited Rajecki (1982) with describing several possible reasons that researchers find a gap between attitude and behavior. First of all, type of experience may have an influence (i.e., direct experiences often result in a higher correlation between attitude and behavior than indirect experiences). Secondly, despite a person's attitude, her behavior is less likely to change if cultural and social norms fail to encourage it. Further, attitudes tend to be "temporally unstable" and change over time. Finally, attitudes are often measured differently than actions, which can result in false reports of attitude-behavior discrepancies.

Connections clearly exist between knowledge, attitude, and behavior. However, the conflicting results of these studies suggest that the traditional KAB model is not adequate to explain the relationships between them. Researchers from a number of different academic fields have developed more sophisticated models of behavior change (see Heimlich & Ardoin, 2008). The next two sections do not present all of these models, but instead provide a basic introduction to some of the more common perspectives in the literature about the best way to influence ERBs. The first section describes models which have been used to promote environmental literacy in various educational settings.

2.5.1 ERB Variable Models

The Hines Model of Responsible Environmental Behavior

One classic example of a theoretical model which attempts to identify the factors impacting ERBs is the Hines model of responsible environmental behavior (Appendix B). Based on the findings from her meta-analysis, Hines (1984) identified three personality factors which directly influence the desire to act: attitude, locus of control, and personal responsibility. A person who possesses the desire to act is more likely to have the intention to act on behalf of the environment (Hines et al., 1986/1987). The Hines model also identified knowledge of environmental issues, knowledge of action strategies, and the relevant skills for applying this knowledge as important contributors to the intention to act. Situational factors (e.g., financial constraints, social pressures) either counteract or strengthen the relationship between the intention to act and the actual performance of a behavior (Hines, 1984; Hines et al., 1986/1987).

The Hines et al. (1986/1987) meta-analysis also suggested that variables affecting environmental behavior can be separated into three categories: cognitive, affective, and situational. Several researchers have used these divisions to design their own models of ERB variables. For example, Pruneau et al. (2006) developed a framework outlining the most commonly cited factors within each of these three categories (Appendix C). They identified ecological knowledge, action knowledge, and environmental awareness as cognitive factors contributing to behavior. Personal responsibility, impression of task ease, and locus of control were some of the affective factors they listed; situational factors included political context, social norms, and an individual's education level (Pruneau et al., 2006).

The Environmental Citizenship Behavior Model

Synthesizing their own work with the efforts of other researchers such as Hines et al., Hungerford and Volk (1990) developed a commonly cited model of ERB variables. Their environmental citizenship behavior model (Appendix D) consists of three categories of variables which are believed to act in a complex but linear fashion. Entry-level variables are pre-requisites to behavior or factors which enhance decision-making, such as environmental sensitivity. Ownership variables, such as knowledge of issues and personal investment, make environmental issues more personal. Empowerment variables give individuals the sense that they can make changes and help resolve issues; these variables include knowledge of environmental action strategies, skill in using environmental action strategies, locus of control, and intention to act (Hungerford & Volk, 1990).

Hungerford and Volk intended their model to be used to guide EE curriculum development. They argued that empowerment variables, especially skill in using environmental action strategies, should be the focus of EE programs. In addition, they suggested “it is probable that the skill component is dependent on the knowledge variable to a great extent” (p. 12). Hungerford and Volk argued that because knowledge of issues and knowledge of action strategies operate in a synergistic manner, instruction in action skills without instruction about relevant issues would be unlikely to result in ERBs. Others have used the environmental citizenship behavior model to research the impacts of EE curriculum on behavior (e.g., Cullen & Mony, 2003; Hsu, 2004; Siemer & Knuth, 2001).

The Hwang et al. Model

Hwang, Kim, and Jeng (2000) developed and tested a causality model for environmental behavior which combined aspects of the Hines model (Hines, 1984; Hines et

al., 1986/1987), the environmental citizenship behavior model (Hungerford & Volk, 1990), and the theory of reasoned action (Ajzen & Fishbein, 1980). Their model postulated that behavior (as seen in a person's intention to act) would be directly impacted by attitude, locus of control, and personal responsibility. Further, they expected that knowledge would directly impact attitude, locus of control, personal responsibility, thereby indirectly affecting the intention to act.

Their study found these variables exhibited direct and indirect relationships with each other. Hwang et al. (2000) reported that environmental knowledge primarily affected the attitude of participants. Attitude and locus of control both had direct effects on the intention to perform ERBs. Personal responsibility was also affected by attitude and locus of control. The researchers concluded that locus of control had the largest effect on the intention to act in an environmentally responsible way, followed by attitude. The predicted and actual causal relationships found in the model are outlined in Appendix E.

Limitations of ERB Variable Models

One of the limitations of the models described to this point is that no consensus exists about which variables are definitely involved in environmentally responsible behavior. Some researchers have argued that there may not be a common set of factors which can explain all ERBs. For example, McKenzie-Mohr, Nemiroff, Beers, & Desmarais (1995) found even within a single behavior (i.e., composting), a different set of variables was involved depending on whether the family composted year-round, seasonally, or not at all. The same was true in a related study of homeowners who installed one of three energy efficient devices; no single set of factors could predict the behavior of all three groups (McKenzie-Mohr et al., 1995). Similarly, when Cotrell and Graefe (1997) identified the predictive variables for pro-

environmental behavior of recreational boaters, they concluded that the factors they discovered were useful in understanding the population they researched, but could not be used to predict other types of ERBs. Barr (2003) agreed, stating that “there are a great many factors to consider when promoting environmental action and... these variables will vary according to the behaviour in question” (p. 237).

Not only do variables differ across behaviors, but different populations also appear to be influenced by different factors. Sia et al. (1986/1987) found perceived knowledge of environmental action strategies to be a significant variable, but Sivek and Hungerford (1989/1990) did not have this result when repeating the study using different populations. In another replication of Sia et al.’s work which focused only on active members of conservation organizations, Marcinkowski (1989) did not find environmental sensitivity to be a significant predictor of behavior, even though both Sia et al. and Sivek did. He even suggested the difference was due his sample population; unlike the participants of the other two studies, the environmentally active individuals who participated in Marcinkowski’s research likely had similar levels of environmental sensitivity.

These models clearly have value to the field of EE. They have been incorporated into various environmental literacy frameworks, used to guide curriculum development, and to build more successful EE programs. However, attempts to incorporate all possible variables can lead to models which are too cumbersome to be of practical use in educational research. In fact, Kollmuss and Agyeman (2002) argued:

... the question of what shapes proenvironmental behavior is such a complex one that it cannot be visualized in one single framework or diagram. Such a single diagram with all the factors that shape and influence behavior would be so complicated that it would lose its practicality and probably even its meaning. (p. 248)

Several alternatives to these models have been proposed which focus on the psychological factors involved in human behavior, rather than on specific antecedents of ERBs.

2.5.2 Human Social Behavior Models

Stern's Value-Belief-Norm Theory of Environmentalism

Unlike the Hines model, which was built from an analysis of studies of environmental behavior, Stern's (2000) value-belief-norm (VBN) model was developed by combining several existing theories about human behavior. Specifically, the VBN model "links value theory, norm-activation theory, and the new environmental paradigm (NEP) perspective through a causal chain of five variables leading to behavior" (Stern, 2000, p. 412). These variables include personal values, beliefs, and norms. Stern postulated that each variable has direct effects on the next variable in the model, as well as effects on variables further down the chain (Appendix F). Four categories of environmental behaviors were identified within the model: activism, non-activist public sphere behaviors, private-sphere behaviors, and behaviors in organizations. Stern argued the VBN model was best suited to explain non-activist public sphere behaviors.

The personal values in the VBN model which form the basis of environmental attitudes and behaviors are: biospheric (concern for the environment), altruistic (concern for the welfare of others), and egoistic (concern for oneself). These values tend to influence certain beliefs, especially ecological worldview beliefs about the relationships between humans and the environment, which Stern referred to as new environmental paradigm beliefs. Personal values and new environmental paradigm beliefs impact other personal beliefs, such as the belief that environmental conditions might have adverse effects on things of personal value ("adverse consequences") and the belief that an individual can act to reduce this threat

(“ability to reduce”). According to Stern, personal moral norms to take pro-environmental action are activated by these beliefs.

The influence of personal norms on ERBs was first described by Schwartz’s (1977) norm activation theory, which suggested that “people are more likely to engage in environmental behaviors when they are aware of the negative consequences and when they believe they have some responsibility for changing the problem” (Monroe, 2003, p. 116). However, norm activation theory focused on altruistic values as the driving force behind ERBs. Stern (2000) attempted to generalize norm activation theory by arguing that other personal values, such as biospheric and egoistic, may also impact beliefs and norms related to ERBs. This idea was initially theoretical, but several recent studies have provided empirical support for the inclusion of all three value orientations (e.g., de Groot & Steg, 2008).

Monroe (2003) argued that Stern’s VBN model and Hungerford and Volk’s environmental citizenship behavior model have several characteristics in common. The entry-level variable of environmental sensitivity described by Hungerford and Volk (1990) may in fact be a measure of a person’s biospheric and altruistic values. Also, Hungerford and Volk’s ownership and empowerment variables tend to align with the beliefs identified in the VBN model. For example, knowledge of ecology could be thought of as new environmental paradigm beliefs, knowledge of issues as beliefs about adverse consequences, and the various empowerment variables as “ability to reduce” beliefs (Monroe, 2003). One significant difference between the models is the inclusion of personal norms in the VBN model.

The Theory of Reasoned Action

Unlike the VBN model which is specific to environmental behaviors, the theory of reasoned action (TRA; Ajzen & Fishbein, 1980) attempts to explain many different types of

human behavior. Ajzen and Fishbein asserted that the intention to behave in a particular way is a function of two primary determinants: attitude toward the behavior, and perception of the social pressure (or subjective norm) to perform the behavior. These attitudes and social norms are influenced by the salient beliefs a person holds about them. Two other constructs in this theory are personal evaluations of attitudinal beliefs (i.e., how positively or negatively a person feels about his own beliefs), and personal motivation to comply with normative beliefs, or how strongly a person feels he must do what others believe he should do (Ajzen & Fishbein, 1980; Staats, 2003). All other variables are considered external; other factors may influence a person's beliefs, they do not directly impact behavior. Appendix G contains a visual representation of this model.

How attitude is defined within the context of the theory of reasoned action differs from typical ERB variable models. Here, attitude refers only to a person's attitude towards a particular behavior. For example, attitude toward composting is considered relevant in predicting composting behavior but general environmental attitudes and environmental sensitivity are not. Ajzen and Fishbein (1980) have argued that attitude has only been shown to be a poor predictor of behavior because researchers tend to determine general attitudes, which may imply a wide range of behaviors, instead of measuring attitude towards the behavior in question. In this way, the theory of reasoned action attempts to address one of the weaknesses of attitude-behavior research.

This theory also postulates that it is necessary to identify the specific details of a behavior in order to understand, predict, and potentially influence it. Every behavior consists of action, target, context, and time elements. For example, in studying recycling behavior, it is important to determine if an individual recycles by using a roadside bin or by driving to a

center (action), what items (cans, bottles, plastic bags) are recycled (target), whether the recycling takes place at home or at work (context), and how often the recycling occurs (time). According to Ajzen and Fishbein (1980), the predictive relationship between intention to act and behavior is dependent on how well they correlate in terms of these four elements.

The theory of reasoned action has been used in a multitude of behavioral studies on a number of topics, including consumerism, health-related behavior, drug use, voting, recycling, water conservation, energy conservation, and environmental activism (see Gotch & Hall, 2004). Until recently, the model had not been tested for its ability to predict behavior as a result of EE. Gotch and Hall (2004) completed the first study of nature-related behaviors using the TRA model. They determined that the model was able to effectively predict the behavior of school children in grades 5-8 who attended a weeklong field science education camp. Interestingly, they found children's attitudes about nature appeared to influence their behaviors more than their perception of the subjective norms surrounding nature-related behaviors.

The Theory of Planned Behavior

The theory of planned behavior (TPB; Ajzen, 1985) grew out of the TRA, with the addition of perceived behavioral control as an important third component impacting behavior (see Appendix H). Like attitude and social norms, perceived behavioral control influences a person's intention to act. This concept was first identified in 1977 by Bandura, who labeled it "self-efficacy" (Ajzen, 1991; Fishbein & Ajzen, 2010). Perceived behavioral control refers to a person's beliefs about how easy or difficult it is to perform a specific behavior, which may vary widely across different situations. According to Ajzen (2002):

When people believe that they have the required resources and opportunities (e.g., skills, time, money, cooperation by others), and that the obstacles they are likely to encounter are few and manageable, they... exhibit a high degree of perceived behavioral control. (p. 677)

Perception, not control, is the most important part of perceived behavioral control. A person's confidence in her ability may differ from her actual level of control, but it is her belief which ultimately impacts her intention to act. This concept was added to the TRA model because all behaviors potentially have some elements which are outside of a person's control (Ajzen, 2002).

Some (e.g., Hwang et al., 2000) consider perceived behavioral control to be the equivalent of internal locus of control, a variable often found in ERB variable models. Internal locus of control refers to "an individual's perception of whether or not he/she has the ability to bring about change through his/her own behavior" (Peyton & Miller, 1980, p. 174). Although the concepts are somewhat similar, Ajzen (1991) argued that internal locus of control is a more generalized belief and therefore not always highly correlated with a person's intention to act. For example, a person may feel that she has a high degree of control over the choice to take public transportation (high internal locus of control) but also believe that taking it is difficult due to the route or the schedule (low perceived behavioral control). As a result, she may feel that she cannot ride the bus to work, even though she knows that the choice of whether or not to do so is her own.

ERB variable models attach great importance to factual knowledge, issue knowledge, and skill knowledge. Conversely, knowledge is considered an external variable in the theory of planned behavior. When testing the effectiveness of the TPB model in four different studies, Ajzen et al. (2011) found participants' attitudes, subjective norms, and perceptions of control could be used to predict intentions, but general knowledge did not appear to be

correlated with behavior. According to this theory, general environmental knowledge and attitudes would not be valuable for predicting ERBs. To state this in terms of a specific environmental behavior:

The intent to recycle will not result from broad information about resource recovery or attitudes supporting environmental policies, but rather will be a function of attitudes about recycling, perceptions of social norms about recycling, and perceived ability to recycle. (Monroe, 2003, p. 116)

Only knowledge and attitudes related to performing a particular behavior are highly correlated with intention (Ajzen, 1991).

The theory of planned behavior provides a particularly useful conceptual framework for attempting to understand complex human social behavior, as it includes only a small number of variables, yet can be used in many different situations. A small number of studies have shown this model to be effective for studying a number of different types of behavior, including environmental behavior (e.g., Ajzen, 1991; Ajzen et al., 2011; Cordano, Welcomer, Scherer, Pradenas, & Parada, 2010; Prinbeck, Lach, & Chan, 2011; see also Staats, 2003). For example, Taylor and Todd demonstrated in 1995 that the intention to perform composting behavior could be predicted from participants' attitudes, subjective norms, and perceived behavioral control (Cordano et al., 2010).

One of the benefits of the TPB model is that it provides a mechanism for identifying salient beliefs related to environmental behaviors. Prinbeck et al. (2011) used the TPB as a framework to investigate recreationists' (i.e., gardeners, fishers, hunters, and boaters) attitudinal, normative, and perceived behavioral control beliefs relative to types of behaviors that could reduce the spread of invasive species, such as pesticide use or responsible boating practices. They concluded that education and communication strategies designed to influence these existing beliefs would be necessary to change participants' behaviors. According to the

TPB, generating effective strategies for behavior change requires an understanding of the underlying beliefs held by the target population.

One potential limitation of the TPB model is that it may not be sufficient to fully explain environmentally responsible behaviors. Researchers using this model have reported that variables such as personal norms, past behavior, and self-identity also have important roles in impacting ERBs (Staats, 2003). Boldero (1995) found past behavior and the formation of habits were predictors of recycling behavior, and that the TPB model alone could not adequately account for participants' actions. Similarly, a study by Harland, Staats, and Wilke (1999) found personal norms improved the prediction of both behavioral intention and actual behavior for five different ERBs. Multiple researchers have reported that self-identity is able to explain additional variance in behavior scores over the TPB model (Staats, 2003).

Another concern with using the TPB model is that it considers the intention to act to be the best measure of the actual performance of a behavior. Ajzen and Fishbein (1980) maintained that the two are strongly connected, and some research does support the idea that intention is highly correlated with behavior. For example, Ajzen et al. (2011) found intention to act was able to explain the largest amount of the variance in actual behavior scores in four different studies. They concluded that "the best single predictor of current or past energy-saving behavior was the intention to do so" (p. 106).

Conversely, others have reported that intention to act and actual behavior are not equal. For example, McBeth and Volk (2010) reported that middle school students scored higher on verbal commitment (i.e., willingness to act) than they did on actual commitment to ERBs, suggesting that students' actual behaviors did not fully reflect their intentions. In another study, Boldero (1995) found that intentions could predict recycling behavior but the

relationship between intention and actual behavior was imperfect. Even Ajzen and Fishbein (1980) have suggested that intention to act may differ from behavior if the person's beliefs or abilities change before the actual behavior takes place.

When comparing the frequency of behavioral intention, self-reported, and other-reported (observed) environmental behavior, Chao and Lam (2011) found the intentions and self-reported ERBs of participants were similar, but both differed from the actual behaviors they performed. They concluded that researchers should be cautious in interpreting study results when only self-reported behavior data is collected. However, the TPB model was found to be more accurate at predicting behavior when self-reported ERBs data (rather than other-reported) were used (Chao & Lam, 2011). This suggests that the theory may be particularly useful when behavior data cannot be collected through direct observation.

The Reasoned Action Approach

Fishbein and Ajzen (2010) recently combined several of their existing theories about human social behavior into their reasoned action approach (Appendix I). This model postulates that “human social behavior follows reasonably from the information or beliefs people possess about the behavior under consideration” (Fishbein & Ajzen, 2010, p. 20). Three kinds of beliefs guide the decision to act in certain ways. First of all, behavioral beliefs about the positive or negative consequences of performing a specific behavior determine a person's attitude toward that behavior. Secondly, both injunctive normative beliefs (i.e., beliefs about the approval of important others, such as a spouse or a boss) and descriptive normative beliefs (beliefs about the actions of others, especially peers) produce a perceived norm about the behavior. Thirdly, control beliefs about personal or situational factors which can help or hinder attempts to perform the behavior lead to a perceived behavioral control.

Together, these three factors (i.e., attitude toward a behavior, perceived norm, and perceived behavioral control) lead to the formation of a behavioral intention. As in the TRA and TPB, intention will be highly correlated with a person's performance of a behavior as long as the intended and the actual behaviors are equivalent in their action, target, context, and time elements. The strength of the intention-behavior correlation is also moderated by how stable the person's intentions are over time, and what degree of actual control the person has over the performance of the behavior (Fishbein & Ajzen, 2010).

A few studies have attempted to use the reasoned action approach to impact environmentally responsible behaviors. One researcher was able to increase the use of public transportation by new residents of a German town using this approach. Bamberg (2006) offered newly-relocated individuals a welcome letter from the local transportation authority, a one-day free pass, and information about routes and schedules. According to Fishbein and Ajzen (2010), Bamberg found these behavioral interventions had a significant impact on participants' attitudes, injunctive norms, perceptions of control, and intentions to use public transportation. Additionally, their actual usage of public transportation more than doubled.

Bamberg's use of the reasoned action approach was reminiscent of methods which are used to "sell" positive environmental behaviors to the public, a method called "social marketing" by McKenzie-Mohr and Smith (1999). Social marketing involves identifying a target population and then tailoring messages to that group using specific techniques. Some social marketing techniques include: reminding people of the ways in which performing a behavior aligns with their view of themselves, advertising the social norms in support of a behavior, offering small incentives for performing a desired behavior, and asking people to make a commitment to doing a behavior (Monroe, 2003). McKenzie-Mohr and Smith (1999)

argued that social marketing has been shown to be more effective at bringing about behavior change than traditional education methods. Similarly, Kollmuss and Agyeman (2002) reported that social marketing appears to be successful in bridging the gap between knowledge and action.

Social marketing techniques align with the reasoned action approach in a number of ways. First of all, social marketing relies on community support. Having community support suggests that social norms will be activated, an important aspect of the reasoned action approach. Secondly, understanding the barriers to behavior change is a major component of social marketing (McKenzie-Mohr & Smith, 1999). One of the strengths of the reasoned action approach is that it can be used to determine the beliefs which might serve as barriers to changing behavior. Third, social marketing specifically targets certain behaviors. Fishbein and Ajzen (2010) have repeatedly asserted that specificity when identifying a behavior is a critical aspect to changing it. The reasoned action approach and social marketing both promote a path to behavior change which involves identifying the beliefs of a target audience followed by the development of specific, persuasive messages.

These techniques have been theoretically applied in informal environmental education settings. For example, Bright, Manfreda, Fishbein, and Bath (1993) suggested using the theory of reasoned action to increase community support for the controlled burns conducted by the National Parks Service. Their study supported the use of the TRA as a framework for developing effective persuasive communication messages for the general public. Similarly, Ham and Krumpe (1996) discussed the development of persuasive messages for a national wilderness area with the goal of increasing visitors' pro-environmental behaviors. In alignment with the reasoned action approach, they attempted to change specific behaviors by

designing communication messages to address behavioral, normative, and control beliefs held by the general public. After determining visitors' beliefs related to these specific behaviors, they developed new trail-side signage which they expected to be more successful at impacting ERBs than previous "problem-targeted" signage.

2.6 Education and Behavior Change

Environmental education interventions which are designed using human social behavior models are significantly different from those based on ERB variable models. Models such as the environmental citizenship behavior model identify environmental behavior change as the final goal of an educational process (Hungerford & Volk, 1990). This change is achieved over a period of time through the development of increasing levels of environmental sensitivity, awareness, knowledge, and skills (i.e., the achievement of environmental literacy). Conversely, models such as the reasoned action approach consider behavior to be the expected outcome of a combination of beliefs. Environmentally responsible behaviors can be changed by determining the specific behavior to be modified and then identifying the relevant beliefs held by a target population. Interventions are specifically designed to address those beliefs and "marketed" to that social group.

There is currently no consensus about which theoretical framework should be used to promote pro-environmental behavior. Both types of models offer a mechanism by which environmental education might be able to influence ERBs. Multiple researchers have concluded that educational interventions which progressively increase the environmental literacy of learners will result in positive behavior changes (e.g., Boerschig & DeYoung, 1993; Borden, 1984/1985; Cullen & Mony, 2003; Hines, 1984; Hines et al. 1986/1987; Hsu,

2004; Hungerford & Volk, 1990; Jordan, Hungerford, & Tomera, 1986; Pruneau et al. 2006; Siemer & Knuth, 2001; Smith-Sebasto, 1995).

Conversely, others have suggested that ERBs are better achieved through the development of educational interventions which specifically target learners' attitudes about certain behaviors, the social acceptability of those behaviors, and the ease of performing them (e.g., Ballantyne & Packer, 2005; Bamberg, 2006; Bright et al., 1993; Gotch & Hall, 2004; Ham & Krumpe, 1996; Monroe, 2003; Prinbeck et al., 2011; Staats, 2003; Stern, 2000). In addition, a number of researchers have argued that no single theoretical approach can be applied to all pro-environmental behaviors, because each ERB has a unique set of variables associated with it (Barr, 2003; Cottrell & Graefe, 1997; McKenzie-Mohr et al., 1995). It is likely that context plays a significant role in the success of a particular model of behavior change. Methods which work well for students in a classroom environment may not be as effective at impacting the general public in an informal setting. This may partially explain conflicting opinions about the best educational interventions for influencing behavior.

Formal and Semi-Formal Educational Settings

In formal education settings, ERBs appear to be influenced more by a curriculum which emphasizes environmental issues, potential solutions, and the development of skills such as issue investigation, problem-solving, and action-taking (Hines, 1984). For example, Hsu (2004) studied a college-level EE course which focused specifically on issue investigation and training in action strategies. The curriculum was effective at increasing students' locus of control, environmental responsibility, perceived knowledge of issues, and perceived knowledge of and skill in using EAS. Further, the course was able to impact both students' intention to act and students' self-reported ERBs, and these increases were still

measurable two months after the course ended. Other studies have found similar results in EE courses which emphasize action training and issue investigation (see Hsu, 2004, Zelezny, 1999).

Smith-Sebasto (1995) also evaluated the impact of a college-level EE course on ERB variables and ERBs. Students who completed an environmental studies course were found to have a higher locus of control, perceived knowledge of environmental action strategies (EAS), and perceived skill in using EAS. Further, only the students taking the EE course demonstrated a significant increase in self-reported ERBs. Smith-Sebasto concluded that all environmental educators should strive to impact locus of control as well as knowledge of and skill in using environmental action strategies in order to more effectively impact their students' behavior.

During many formal education programs, students have opportunities to participate in activities which differ from their day-to-day lessons. For example, learners may travel to a remote location for a field trip, receive an outdoor lesson in the schoolyard, or have a guest speaker visit their classroom. Although these experiences are less “formal” than instruction in a classroom setting, they are still considered an aspect of formal education. Some research has been done to evaluate these “semi-formal” experiences and their possible influence on environmentally responsible behaviors.

Boerschig and DeYoung (1993) reviewed the curricula of 14 solid waste management education programs using the variables identified by Hines et al. (1986/1987) as strong predictors of ERBs. They found the EE curricula tended to focus on knowledge, attitude change, and action strategies while mainly ignoring other variables, such as skills, locus of control, and personal responsibility. Although the study did not specifically measure ERBs,

Boerschig and DeYoung speculated that the curricula would be more effective if they addressed all of the variables identified by Hines et al. as predictors of ERBs, and recommended including these missing factors to further promote pro-environmental behaviors in participants.

A national fishing education program designed for children in grades 6-8 (“Hooked on Fishing - Not on Drugs”) was also able to impact some of the variables related to ERBs (Siemer & Knuth, 2001). Specifically, HOF-NOD participants had greater ecological knowledge, awareness of issues, knowledge of how humans impact the environment, and awareness of ERBs and environmental action strategies. However, only the lowest variables (i.e., “entry-level variables” as defined by Hungerford & Volk, 1990) were well addressed in the curriculum. Consequently, the program was unsuccessful at impacting some higher level variables, such as personal responsibility, locus of control, and skill in using EAS. As with the Boerschig and DeYoung study, the researchers did not directly measure participants’ ERBs, so were unable to draw any definitive conclusions about the program’s impact. Siemer and Knuth also cautioned that their findings could not be generalized to other EE programs.

Few researchers have directly observed the pro-environmental behaviors of participants in a semi-formal EE program. In one study, Palmberg and Kuru (2000) found school children who were exposed to outdoor EE experiences had increased levels of environmental knowledge and values, but also exhibited negative environmental behaviors such as littering. These types of behaviors were observed in even the most environmentally-minded youths, supporting the contention that knowledge and attitudes are not directly correlated with behavior. The researchers offered several possible explanations for this

discrepancy, but concluded that another study would be needed to account for the variations in behaviors they observed.

To summarize, a number of individuals in the EE field have developed models of the likely cognitive, affective, and situational variables impacting ERBs (e.g., Hines, 1984; Hungerford & Volk, 1990; Pruneau et al. 2006). There is some evidence that traditional methods of instruction are able to influence these variables, especially environmental sensitivity, locus of control, perceived knowledge of EAS, and skill in using EAS (Hines et al., 1986/1987; Hsu, 2004; Smith-Sebasto, 1995). Further, environmental education curricula which emphasize issue investigation, action training, and problem solving have been shown to be more effective at influencing these variables and increasing learners' self-reported ERBs. Despite these successes, school-based EE programs only reach some Americans; therefore, they are only one part of the solution to increasing environmental literacy at a national level.

Non-Formal Education Programs

Formal education is the term most often used to denote school-based learning. In contrast, non-formal (or informal) education is typically a catch-all phrase for a wide range of learning opportunities and settings outside of schools (Falk & Dierking, 1992; Ham & Krumpe, 1996). The term informal education may refer to an evening lecture series, a weekend nature camp, or a permanent museum exhibit. Lectures and camps are examples of non-formal education programs. Unlike an exhibit, a non-formal education program has a defined curriculum, specific beginning and ending times, and a knowledgeable facilitator who chooses content and guides the learning experience. Exhibits such as those offered by a zoo or a museum may be experienced as part of a non-formal education program (e.g., guided tour), but are also accessible to the general public. This section discusses the literature specifically

related to non-formal programs and their impact on ERBs. The ability of exhibits to influence the behavior of general public visitors is reviewed in section 2.7.

In her meta-analysis, Zelezny (1999) found non-formal EE programs were less effective at impacting behavior than traditional learning settings. They also tended to be shorter and have less participant involvement, suggesting that time and active participation may be related to promoting ERBs. However, Zelezny hesitated to draw any broad conclusions about non-formal EE programs and their impact on behavior because she only analyzed 18 studies (nine formal and nine non-formal) and not all of the studies were of equal quality.

There is some evidence that non-formal EE programs which are modeled after formal educational settings are successful at increasing both knowledge and behavior. When teenage participants of a non-formal EE workshop were given instruction in both environmental issues and action strategies, they demonstrated a greater knowledge of environmental action and performed more ERBs than when given instruction on environmental issues alone (Jordan, Hungerford, & Tomera, 1986). The researchers concluded that non-formal environmental educators should collaborate with schools to design the most effective programs.

Westphal and Halverson (1985/1986) attempted to determine long-term (i.e., 5 months) behavioral changes which resulted from a non-formal public lecture series on Lake Michigan. Participants became more active in political issues after attending the lectures, but there was little evidence that other ERBs had been affected by the program. However, the lecture series did not have behavior change as one of its goals, which might explain why the program did not have a large impact on participants' actions.

Dresner and Gill (1994) evaluated the impact of a two-week long summer nature camp on children's interest in the natural world, naturalist skills, self-esteem, and environmentally responsible behavior. They concluded the program positively impacted behavior, but their main examples of "ERBs" were environmental sensitivity, issue awareness, and appreciation for nature. In other words, the camp appeared to successfully impact several variables related to ERBs rather than actually changing participants' pro-environmental behaviors.

When Kruse and Card (2004) researched environmental knowledge, attitudes, and behavior of day camp participants at a Florida zoo, they could find no clear trend in the pre- and post-test measures for ERBs between different groups of campers. Even though a slight increase in self-reported ERBs occurred immediately following the camps, this value actually dropped below pre-camp levels one month after the camp had ended. Kruse and Card also found youth who participated in multiple camp experiences reported just as many ERBs as those who had only one day camp experience. These data suggest that the conservation day camps were unsuccessful at impacting actual behaviors for any length of time.

Culen and Mony (2003) studied the environmental behavior of youth who participated in EE activities as part of Florida's 4-H program. As discussed in section 2.2, they reported that children who were exposed to EE activities in 1998 did not perform significantly more ERBs in 2002 than they did at the beginning of the program. Further, there was little difference in ERBs between the 4-Hers and a control group who did not participate. Culen and Mony speculated that the EE program may have failed to impact ERBs because it did not address environmental issue awareness, knowledge of environmental action strategies, or skills involved in using EAS. They concluded that the 4-H program increased ecological knowledge, but was unable to modify behavior.

In general, non-formal programs do not appear to be very successful at promoting ERBs. A majority of studies reported no significant changes in pro-environmental behavior as a result of non-formal programming (Culen & Mony, 2003; Dresner & Gill, 1994; Kruse & Card, 2004; Westphal & Halverson, 1985/1986; Zelezny, 1999). One potential solution may be to model non-formal programs after classroom-based instruction, as suggested by Jordan, Hungerford, and Tomera (1986). However, the National Research Council has asserted that goals and measures of achievement should be different in non-formal education settings (NRC, 1999). An alternate solution is to find approaches to changing behavior which are more successful in non-formal environments, as well as different metrics for measuring success which are more appropriate for non-formal learners.

2.7 Informal Science Learning Environments

Falk and Dierking (2010) stated that the vast majority (95%) of learning which takes place during a person's lifetime occurs outside of formal educational settings. This type of learning is often referred to as "free-choice." According to Falk (2005), free-choice learning refers to "the type of learning that occurs when individuals exercise significant choice and control over their learning" (p. 270). Reading a newspaper at home, attending a talk at the library, and taking a dance class at a studio are all examples of free-choice learning situations, as are the non-formal programs discussed in the previous section of this review. Many locations can become free-choice learning environments, including one's home, workplace, and school. Science learning can take place in free-choice settings. Watching a documentary about sharks is an example of a free-choice activity where science learning may occur.

Free-choice science learning frequently occurs in informal science learning environments (ISLEs). The term ISLE refers to an educationally-focused, non-school location

which exposes people to science concepts in a semi-structured or unstructured way. Some common examples of ISLEs are zoos, aquariums, science museums, botanic gardens, and nature centers. These settings allow visitors many options about what to learn as well as a great deal of control over their personal experiences. Most importantly, informal science learning environments provide the general public with reliable and accessible sources of scientific information.

Informal, free-choice learning experiences such as those provided by ISLEs play an important role in the field of EE. The Tbilisi Declaration identified non-formal education as a critical component in delivering EE to the general public (UNESCO, 1978). One of the main goals of the EPA's Office of Environmental Education is to support EE in both formal and non-formal settings, as environmental education involves a lifelong learning process (NEEAC, 2005). Hsu and Roth (1999) asserted that ISLEs can help to maintain and reinforce the knowledge and skills learned in formal EE programs, and to retain a level of environmental literacy in formal education system graduates. Coyle (2005) also promoted the use of ISLEs to increase the environmental knowledge and skills of the general public.

The learning which occurs in informal science learning environments differs from the learning which takes place in schools. School-based learning is typically other-directed and obligatory, whereas learning in ISLEs is most often self-directed and voluntary (Falk & Dierking, 2000). Also, ISLE visitors have the freedom to choose how they will interact with material that is presented to them. For this reason, interpretive messages delivered by ISLEs "should not be viewed as a teaching or instructional activity in the academic sense" (Ham & Krumpe, 1996, p. 12), but as the delivery of content to a "non-captive" audience. In free-choice settings, participants very often learn something different from what was intended by

the setting's designers (Ballantyne & Packer, 2005; Falk, 2005). Thirdly, visitors are more likely to be looking for entertainment than knowledge (Ballantyne, Packer, Hughes, & Dierking, 2007). However, Falk & Dierking (2002) stated many visitors are in fact looking for an educational experience, as Americans are increasingly seeking out learning for enjoyment.

The majority of educational research that has taken place in ISLEs and other free-choice settings has been focused on learning. A commonly used theoretical construct for understanding free-choice learning is the contextual model of learning (Falk & Dierking, 1992, 2000), which posits that learning is both the process and product of the interactions between three contexts over time - the personal (self), the sociocultural (group), and the physical (location). Central to the contextual model is the role of prior knowledge, interest, and beliefs in creating learning experiences. According to Falk and Dierking (2000), museum learning is deeply personal because it is linked to an individual's existing knowledge and beliefs, interest level, previous museum experiences, and subsequent life experiences. This model has a great deal of support in the literature as an effective framework for understanding learning in ISLEs.

The terms "environmental learning" or "conservation learning" are commonly used to refer to learning about the environment in a free-choice setting. Falk (2005) described environmental learning as a highly personal and meaningful process which takes place over a long period of time, is context-dependent, and involves a variety of sources. Learning about the environment can occur in many different ways. Coyle (2005) explained:

In the course of a lifetime, an individual will accumulate environmental knowledge from a combination of school, the media, personal reading, family members and friends, outdoor activities, entertainment outlets, and a wide range of other professional and personal experiences. (p. v)

However, these settings are not equal in terms of the environmental knowledge they offer. For example, a documentary produced by NOVA may contain more complete and scientifically accurate information than an Internet article. The media is an especially common source of environmental information for both children and adults, but one which often fails to represent environmental issues fully or accurately (Coyle, 2005). For this reason, ISLEs are an important source of high-quality EE for the general public.

Ballantyne, Packer, Hughes, and Dierking (2007) claimed that captive wildlife encounters (e.g., zoo visits) have been shown to positively impact visitor' conservation learning. These experiences allow visitors observe animal behavior and provide opportunities for close encounters with wildlife while engaging visitors' emotions and connecting with their prior knowledge and experiences. Further, exhibits often use persuasive communication to link everyday actions to conservation, as well as provide incentives to support visitors' conservation behaviors (Ballantyne et al., 2007). Similarly, Kola-Olusanya (2005) asserted that learning environments such as museums, zoos, nature centers, parks, and wilderness areas are ideal for promoting environmental learning.

Although informal science learning environments have the potential to increase environmental learning, their efforts to impact pro-environmental behaviors have not been entirely successful. Simmons (1991) examined how well the goals of U.S. nature centers aligned with models of environmental behavior, especially the Hines model (Hines et al., 1986/1987) and the environmental citizenship behavior model (Hungerford & Volk, 1990). Nearly 75% of the 1200 centers she surveyed considered the encouragement of ERBs to be a goal, yet most lacked related goals needed to achieve it. For example, increasing knowledge of environmental issues was a goal for fewer than half of the centers, and goals for the

development of problem-solving skills, environmental attitudes, and other factors were similarly lacking. Further, even though nearly 80% of the centers stated that they were teaching EE, most did not incorporate the goals identified for EE in the Tbilisi Declaration. Simmons concluded that “for the most part, centers are endorsing a behavior model that simplistically links nature study directly to environmental behavior” (p. 21).

However, it is unclear what types of goals and expectations informal science learning environments should have regarding changes in the environmental behaviors of visitors.

According to Ballantyne and Packer (2005):

It is important to interpret these learning outcomes in their broadest sense.... changes in behaviour may involve lifestyle changes, talking to others about environmental issues, joining volunteer programmes, or donating to environmental organisations. It may involve changes in actual behaviour, or changes in behavioural intentions. (p. 283)

Similarly, Storksdieck, Ellenbogen, and Heimlich (2005) argued that learning outcomes of free-choice environmental education should be more broadly defined to include general increases in appreciation, understandings, and skills, as well as incidental learning and reinforcement of existing knowledge, attitudes, and beliefs.

There are also a number of difficulties associated with conducting behavior research involving general public visitors to ISLEs. As explained by Dierking, Adelman, Ogden, Lehnhardt, Miller, and Mellen (2004):

Behavior change, particularly in an area such as conservation, is complex, takes considerable time and is difficult to discern, thus it has proven challenging to document and measure the extent to which free-choice learning institutions... achieve their educational mission of influencing subsequent behavior and action in this area (p. 323).

Long-term data is often more difficult to obtain from general visitors than from program participants. In addition, the general public may be less inclined to participate in a research

project which takes time away from their visit to an ISLE. These challenges can limit the scope of potential studies. Still, a handful of studies have attempted to evaluate the impact of informal science learning environments on the ERBs of general public visitors.

Swanagan (2000) compared visitors' experiences with an elephant exhibit to their willingness to sign a petition against the ivory trade or to write letters to legislators. He found only "modest support" for the claim that active experiences (such as educational shows or docent interactions) may promote active conservation behavior. Further, a major limitation of this study was that the design may have pressured visitors into performing the behaviors being measured.

In a study to determine the impact of the National Aquarium in Baltimore on visitor knowledge, attitudes, and behaviors, Adelman, Falk, & James (2000) asked visitors to share their thoughts and plans for conservation actions immediately after their visit, as well as their actual lifestyle changes two months later. The researchers found significant changes to visitors' conservation knowledge, understanding, and interests but "...there was no evidence that a visit to the NAIB changed the visiting public's conservation actions" (p. 55). In fact, they reported that even visitors' general enthusiasm for conservation behaviors tended to wane in the months following their visit. Adelman et al. concluded that visiting the aquarium had a positive effect on visitor knowledge and attitudes in the short term and knowledge in the long term but little to no impact on visitor behavior.

Dierking et al. (2004) attempted to study the intended conservation behaviors of visitors to Disney's Conservation Station using the Prochaska stage model of behavioral change. They arranged participants on a continuum of behavior levels, from pre-contemplative to active, and compared these levels to their intentions to perform conservation

actions. Visitors in the middle levels of the continuum reported an increase in their intention to perform one or more of 11 different conservation actions immediately after their visit, but these intentions had waned two to three months after their visit. Also, as the Prochaska stage model was limited in its ability to measure small changes over multiple behaviors, Dierking et al. concluded that it might not be the best model to understand how behavior is impacted by free-choice learning experiences.

These studies suggest that informal science learning environments are relatively unsuccessful at changing the behavior of general public visitors. According to Falk (2005), “although many zoos and aquariums specifically design their messages so as to influence the public’s conservation behaviors, little positive long-term change in the public’s environmental behaviors seems to result” (p. 276). However, research has not yet been done to determine the effects ISLEs do have on the general public’s pro-environmental behaviors, or why they might be struggling to change behavior in the long term.

2.8 Summary

Environmental education has been changing since its emergence, and has been influenced by many voices. Some would argue that the field remains in turmoil (e.g., Hungerford, 2010). Yet the goals most often agreed upon by EE practitioners today are still those which were set forth in Tbilisi almost 35 years ago (i.e., that EE should foster awareness and concern, increase knowledge, attitudes, and skills, and create new patterns of behavior). Most would also agree that the overarching goal of EE is the creation of an environmentally literate society.

Like environmental education, environmental literacy has been conceptualized in multiple ways. Roth’s (1992) definition is one of the most commonly used. He described

environmental literacy as a continuum in which a person's level of competence in environmental awareness, concern, understanding, and action increase over time. Many also agree with Coyle's (2005) statement that true environmental literacy is only achieved when a person consistently behaves in an environmentally responsible way.

Despite multiple efforts to provide national direction and guidance for EE, including the National Environmental Education Act, NAAEE's Guidelines, and NEEAC's Report to Congress, most American citizens still perform poorly on measures of environmental literacy. This is particularly concerning because of the need for a higher level of national literacy in order to effectively meet the global environmental challenges we will face in the 21st century, such as natural resource shortages and climate change.

In an effort to increase environmental literacy, researchers have studied the factors which likely impact environmentally responsible behaviors and have developed a number of theoretical models of behavior change. These models fall into two groups, ERB variable models and human social behavior models. ERB variable models represent the best ideas from an educational perspective on how to impact behavior. They outline the knowledge, attitudes, and skills educators should focus on to most successfully change ERBs. Human social behavior models offer an alternative approach to changing behavior. They identify the beliefs, attitudes, norms, and perceptions which should be addressed in order to impact pro-environmental behaviors.

There is no consensus about which type of model is better at promoting behavior. Both theoretical frameworks have been supported by multiple studies. ERB variable models have been shown to be successful in formal educational environments as well as some non-formal programs (Hines et al., 1986/1987; Hsu, 2004; Jordan et al., 1986; Smith-Sebasto, 1995).

Human social behavior models have proven to be useful for understanding the pro-environmental behaviors of the general public (Ajzen, 1991; Ajzen et al., 2011; Bamberg, 2006; Cordano et al., 2010; Gotch & Hall, 2004; Prinbeck et al., 2011). There is a lack of research on using these models to promote ERBs in informal settings.

Several hurdles exist to changing behavior with education. First of all, numerous studies have reported that increasing a learner's knowledge does not appear to translate into changes in behavior. Yet many environmental awareness campaigns and EE programs continue to operate under this assumption. For example, it is not unusual for a museum to build a display listing the many reasons to recycle, an aquarium to generate informative pamphlets about water conservation, or a zoo to create a website devoted to rainforest facts. Unfortunately, educational efforts of this type have been shown to be ineffective at influencing pro-environmental behaviors (Barr, 2003). Secondly, significant obstacles may exist for learners even if educational programs are well designed. Kollmuss and Agyeman (2002) identified many potential barriers to environmental behavior change, including a learner's prior knowledge, values, or habits. Prinbeck et al. (2011) found existing beliefs about specific ERBs served as barriers to the performance of those actions, even in environmentally-minded individuals.

Regardless of these hurdles, changes in human behavior are needed to overcome the current challenges facing the environment. Even though non-formal programs and exhibits have historically not been as successful as formal schooling at promoting environmentally responsible behaviors, they do have great potential for several reasons. A person may be more motivated to learn in an informal setting because she is participating in personally meaningful activities (Falk & Dierking, 2000). ISLEs can also provide important reinforcing experiences

for school-based environmental learning (Hsu & Roth, 1999). Thirdly, informal science learning environments reach wider and more diverse audiences than school-based environmental education programs (NRC, 2009), suggesting they can have a much greater impact on the general public.

This literature review has attempted to provide the reader with an overview of the historical and contemporary work which has been done in both formal and informal environmental education with regards to environmentally responsible behaviors. Using the personal experiences of museum visitors, this study seeks to add to this body of literature by forwarding a model of behavior change which, although developed within the context of a single exhibit, is relevant and useful to informal science education researchers and practitioners.

3. METHODOLOGY

This chapter begins by providing a rationale for using an exploratory case study as my principle methodology. This is followed by an outline of the research design used in this study including a description of the research site and how it was chosen. The main research question and five sub-questions, the propositions, and the theoretical perspectives that guided the study are discussed. This methodology also describes the strategies I used during data collection and analysis. Finally, this chapter seeks to establish the study's validity and reliability.

3.1 Rationale for a Qualitative Study

Qualitative research stems from the ontological position that reality is subjective and participatory (Daly, 2007). It has the distinct benefit of allowing a researcher to look at human problems deeply and significantly, and is especially valuable for answering why and how questions. Qualitative research includes: natural settings, holistic and emergent designs, interpretive inquiry which relies on multiple sources of data and the researcher as a key instrument, inductive data analysis, and a focus on participant meanings (Creswell, 2009).

Participant meanings are relatively absent from the literature on environmentally responsible behavior. Almost all of the existing research has been conducted using quantitative procedures, with a focus on finding correlations between predictive variables and behavior (e.g., Ajzen et al., 2011; Bamberg, 2006; Boldero, 1995; Borden, 1984/1985; Bright et al., 1993; Chao & Lam, 2011; Cordano et al., 2010; Cottrell & Graefe, 1997; Culen & Mony, 2003; Dresner & Gill, 1994; Gotch & Hall, 2004; Hsu, 2004; Hsu & Roth, 1999; Hwang et al., 2000; Jordan et al., 1986; Kruse & Card, 2004; Prinbeck et al., 2011; Sia et al., 1985/1986; Siemer & Knuth, 2001; Smith-Sebasto, 1995; Smith-Sebasto & Fortner, 1994; Westphal & Halverson, 1985-1986). Some recent studies of ISLE visitors used qualitative

techniques (e.g., Adelman et al., 2000; Brody, Tomkiewicz, & Graves, 2002; Falk & Storksdieck, 2005), but these looked at visitor learning rather than pro-environmental behavior. Efforts to understand the impact of ISLEs on conservation behavior have relied primarily on statistical analyses (Bright et al., 1993; Dierking et al., 2004; Swanagan, 2000). I felt that an exploratory case study could yield valuable insights as one of the first efforts to investigate the specific behavioral impacts of an ISLE exhibit using a qualitative lens.

In the context of an empirical study, the term “case” refers to a concrete phenomenon, such as an individual, process, or event. According to Stake (1995), cases of interest in education tend to be people or programs. The term “case study” is more difficult to define. Historically, the phrase has been used to refer to many different types of research, including ethnographies and participant-observation studies (Yin, 2009). Gerring (2007) described a case study as the intensive study of a single case or small number of cases (i.e., sample) in order to shed light on a larger class of cases (i.e., population). Conversely, Stake argued that case studies are not meant to be used as a method for understanding other cases, but are undertaken mainly to gain a more in-depth understanding of a single case. According to Yin:

A case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. (p.18)

Further:

The case study inquiry copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result benefits from the prior development of theoretical propositions to guide data collection and analysis. (p. 18)

In developing this study, I followed Yin’s conceptualization of a case study as well as his suggestions for designing and undertaking case study research.

Yin (2009) discussed a number of traditional objections to case study research. One of the main criticisms in the literature is that case studies cannot provide a basis for scientific generalizability. Yin argued that the results of case studies, although they cannot be generalized in the same way as statistical analyses, can still be useful in expanding and generalizing theories - a trait he called “analytic generalizability.” Secondly, case studies may not be valuable for observing the effect of experimental treatments. However, Yin claimed they can still provide important complementary data to experimentally-based research, and can answer questions for which quantitative research methods are unsuitable. A third criticism is that the methods used in a case study may lack rigor. According to Yin, these concerns can be addressed through a careful and thorough outline of procedures.

3.2 Research Design

A case study research design should identify the unit(s) of analysis, the research question(s), the propositions, the logic linking the data to the propositions, and the criteria for interpreting the findings (Yin, 2009). It should also explain the procedures for developing validity and reliability. Thirdly, the theories which guide the case study should be developed prior to data collection. Even exploratory studies such as this one, where no robust theoretical framework exists in the literature, should provide a theoretical rationale and direction. Specifically, the design should include a description of “what is to be explored, the purpose of the exploration, and the criteria by which the exploration will be judged successful” (Yin p. 37). The following sub-sections attempt to describe these aspects of the research design.

3.2.1 Research Site Selection

Selecting a unit of analysis for case study research requires a thoughtful consideration of the available options. I initially narrowed my search by reviewing the websites of more

than 50 informal science learning environments in the United States, looking for those which were especially environmentally-focused in their mission, goals, or topics. “Environmental” topics include: Earth systems and resources, the living world, populations, land and water use, energy resources and use, pollution, and global change (The College Board, 2011).

Approximately 25 ISLEs met this initial requirement.

Next I considered each ISLE’s potential to be influential, based on criteria such as location, years in operation, size, and annual visitation. Sites open to the public for longer periods of time, having larger numbers of visitors each year, or located in large metropolitan areas or popular travel locations were considered more heavily than other candidates. This set of criteria reduced the pool of potential ISLEs to about 10 locations. Within this group, I looked for learning environments offering exhibits and programs aligned with contemporary ideas on how to engage the public. Specifically, audience-focused exhibits about topics which are relevant to the public seem to be more successful in informal science settings.

Koster & Schubel (2007) suggested making exhibits relevant, meaning they address local or global contemporary issues. Relevant exhibits can make the public more aware of environmental issues and help them feel connected to a larger community experiencing the same problems. Displaying environmental issues which have not yet been solved can also help visitors feel empowered, because there is still something that they can personally do about them. Mayfield (2004) claimed visitors should be allowed to choose what science content to engage with during a museum exhibit, rather than having it disseminated to them. Audience-focused attractions allow the learner to build on prior knowledge and connect with their attitudes and feelings. They also encourage learners to take ownership of their own experience by appealing to their wants and needs. Along the same lines, Munley, Roberts,

Soren & Hayward (2007) suggested that museum exhibits be customizable, because this gives visitors more choices and greater control. Customizable exhibits allow visitors to focus on what is personally meaningful to them, making it more likely that they will learn the information being presented.

From this selection process, the California Academy of Sciences in San Francisco, CA emerged as a high-quality ISLE with the potential to influence the environmentally responsible behavior of visitors. The Academy first opened in 1853. It is the fourth largest natural history museum in the United States, containing an aquarium, planetarium, and a natural history museum. The Academy receives about 1.5 million visitors each year (Scott Moran, personal communication, October 24, 2011). The museum is a worldwide leader in research, education, and community environmental efforts. Each quarter the museum publishes *Curator: The Museum Journal*, a refereed publication which provides a forum for museum professionals. The Academy was also the Sierra Club's first home and helped to establish Yosemite National Park and Big Basin California's first state park (Kociolek, Piano, & Rogers, 2005).

Many of the Academy's exhibits showcase biodiversity and ecological relationships using living animals and plants, and its Naturalist Center gives the public access to resources and information about the environment. The Academy hosts a number of environmental programs for visitors, including the Bio Forums, planetarium shows, and daily guided experiences such as "Explore the Living Roof with a Naturalist." In addition, the *Altered State: Climate Change in California* exhibit offers visitors a look at how climate change impacts their lives both locally and globally, and the *Building Green* exhibit shows visitors how the Academy is living its own messages about being environmentally responsible.

Yin (2009) suggested defining a case study's unit of analysis based on both the scope of the initial research questions and the ability to complete the work. Although the entire California Academy of Sciences would have provided a unique context for a study of visitor behavior, my study questions as well as time and resource restrictions required a more focused unit of analysis. Of the exhibits currently offered by the Academy, *Altered State* has the strongest emphasis on visitor action, making it the best choice to examine how an exhibit might influence pro-environmental behavior.

The *Altered State* exhibit typifies a contemporary museum exhibit. It contains text panels, images (still and video), preserved specimens, live animals, manipulatives, and the presence of docents or museum staff. According to Gerring (2007), a typical case may be valuable in a case study because, as a representative of a broader set of cases, it can provide insight into the broader phenomenon of interest. Similarly, Yin (2009) asserted that "the lessons learned from these cases are assumed to be informative about the experiences of the average person or institution" (p. 48). As one of the main purposes for this research was to provide suggestions for future exhibit design, it was reasonable to select an exhibit which represented a typical offering by a large, successful museum.

3.2.2 Access to the Site

The term "gatekeeper" is commonly used in ethnographic studies to refer to an insider within a cultural group who helps the researcher to gain access. My gatekeeper for the California Academy of Sciences was the museum's Director of Exhibits, Scott Moran. According to Bogdan and Biklen (1992), gatekeepers may ask an ethnographic or case study researcher to provide specific information about why a certain site was chosen, what will be

done there, how disruptive it will be, how the results will be reported, and what the benefit will be to the study participants (cited in Creswell, 2007).

Mr. Moran met with me during my first tour of the Academy, giving both of us the opportunity to ask questions and voice concerns. We also discussed how the study might impact visitors and how the findings might benefit the museum in the future. He told me he was excited about the research and offered to send me the report from the 2009 summative evaluation discussed in section 1.4. Before beginning to collecting data, I confirmed with Mr. Moran that I would be using the Academy as my primary research site and provided him with final versions of the project description, interview protocols, and consent form to be used in the study. This gave him a second opportunity to discuss concerns or questions about the study prior to my contact with museum visitors. Mr. Moran also provided me with visitor data from the 2011 annual visitation report (see section 4.2.3).

3.2.3 Research Questions and Propositions

My primary research question for this study was: “How does the *Altered State: Climate Change in California* exhibit influence the intended and actual environmentally responsible behaviors of adult visitors to the California Academy of Sciences?” I developed a theoretical framework from the existing literature which helped to focus my data collection and analysis: 1) A museum exhibit influences different visitors in different ways, and the same visitor in multiple ways, 2) An exhibit can impact visitors’ intention to perform certain behaviors, 3) The design elements and messages of an exhibit can have a positive impact on visitor intentions, and 4) The actual performance of behavior may be different from visitors’ intentions. These propositional statements were also used in the development of the five sub-questions which guided the study:

1. What are visitors' intentions regarding their performance of environmentally responsible behaviors immediately after experiencing this exhibit?
2. How do these intentions compare to actual self-reported behaviors several weeks later?
3. What reasons do visitors give for differences between their intentions and actual behaviors, if any?
4. What components of the exhibit's design seem to influence visitor intentions and/or behaviors?
5. What environmental messages do visitors appear to take from the exhibit, and how do they seem to influence visitor intentions and/or behaviors?

3.2.4 Participants

Qualitative techniques tend to rely on purposeful sampling strategies to identify participants because meaningful data are being sought from a small group (Creswell, 2007; Kenney, 2009). However, studies of ISLE visitors have tended to use random sampling in an effort to select participants who are broadly representative of the typical visiting public (Adelman et al., 2000; Bright et al., 1993; Dierking et al., 2004; Falk & Storksdieck, 2005; Swanagan, 2000). Consequently, the literature does not offer an established method for determining a purposeful sample of ISLE visitors.

According to Novey and Hall (2006), time spent in an exhibit has been shown to have a moderate to strong positive correlation to knowledge gain. When selecting candidates for her study of museum visitors, Jeffery (1999) approached families who spent a significant amount of time exploring a particular aquarium exhibit. The majority of Academy visitors (48%) spent between one and five minutes in the *Altered State* exhibit; only 12% were found to spend more than 10 minutes (Randi Korn & Associates, Inc., 2009).

I chose to use an approach similar to Jeffery's (1999) to select study candidates. Some visitors spend more time in an exhibit and display more signs of interest and engagement than the average visitor, such as pointing, a slowed walk, discussion of the exhibit contents, interactions with staff, and use of hands-on activities. These highly engaged individuals represent the "bright spots" amongst the general population of visitors. In describing strategies for promoting behavior change, Heath and Heath (2010) used the term bright spots to refer to "flashes of success" that "can illuminate the road map for action" (p. 48). I felt that conversations with the brightest spots would yield the richest and most meaningful data.

Using Jeffery (1999)'s sampling size as a guideline, my goal was to conduct 15-20 interviews of highly engaged adult visitors who were visiting alone or in groups of two to four people. I chose to interview group members together as it aligned with how they experienced the exhibit. Adults who otherwise met the criteria for the study were not approached if they were visiting with children. Although a significant amount of research has been done on family groups in museums, very little data exists on adult museum visitors (Dufresne-Tasse, 1995). Also, as suggested by Brody et al. (2002), visitors who seem rushed or preoccupied were not approached.

To ensure the safety of participants, an application for approval was submitted to LSU's Institutional Review Board. Appendix J contains the approved application including a description of the project, the consent form used in the study, a signed security of data agreement, and a certificate showing my successful completion of the National Institute of Health's online training course "Protecting Human Research Participants." The study protocols found in Appendices K -M were also included in the application.

3.2.5 Data Collection

As with many types of qualitative research, case studies rely on multiple sources of data. Data collected in multiple ways increases the validity of a study through triangulation. Triangulation is a strategy involving “corroborating evidence from different sources to shed light on a theme or perspective” (Creswell, 2007, p.208). In this study, I used four data sources: 1) observations of visitors, 2) face-to-face interviews, 3) follow-up phone interviews, and 4) an analysis of related documents, text panels, and visuals.

As part of document analysis, I reviewed the report from the 2009 summative evaluation of the *Altered State* exhibit. The study was conducted by Randi Korn & Associates expressly for the California Academy of Sciences. It determined demographic data, the amount of time visitors spent in the exhibit, and their overall experiences. This evaluation provided an important additional source of observation and interview data collected by independent researchers. In addition, I examined the exhibit’s text panels, object labels, photographs, and movie contents prior to conducting observations or interviews. During my initial site visit, I photographed each panel, label, and visual, and took video footage of some parts of the exhibit. Examining these sources helped me when observing visitors, and later to respond appropriately when interviewees referred to specific parts of the exhibit. It was also valuable during data analysis when searching for common themes across all data sources.

Prior to conducting interviews, I spent approximately six hours across three different time periods observing visitors in the *Altered State* exhibit. I was as unobtrusive as possible to limit my impact on visitor behavior. Although I did take note of families, school groups, teens, and other visitors, I focused my observations primarily on adult groups so that observation and interview data could be compared. I noted areas where adults preferred to

interact with the exhibit's contents as well as evidence of increased interaction with the exhibit: stopping often to read panel or look at visuals, touching objects, manipulating sections of the exhibit (e.g., moving the balance, writing on a card), talking to others (including staff members or volunteers) about the exhibit. The main purpose of the observation was to begin to discover how visitors navigated the exhibit and which aspects attracted the most attention. I also wanted to develop a feel for how much time adults were actually spending in the exhibit compared to the findings in the summative evaluation. As suggested by Creswell (2009), I recorded two types of field notes: descriptive (e.g., visitor actions and behaviors) and reflective (e.g., hunches, personal connections). Appendix K contains an example of the protocol I used to record observational field notes.

The initial post-visit interviews took place over the course of one week. A total of 31 people were interviewed across 16 interviews. Visitors who gave their consent were asked questions from the face-to-face interview protocol (Appendix L). The interviews were conducted in a semi-structured fashion. In other words, the order and wording of the questions differed in each interview. Also, when a relevant theme appeared during an interview it was sometimes pursued with additional questions. I could not anticipate these questions so they are not found on the protocol. At the conclusion of each interview I asked participants to complete a short survey containing demographic data (Appendix N). The interview protocol was structured so that the majority of interviews would fall between 15-30 minutes. Based on the relevant literature, this seemed to be the longest amount of time that ISLE visitors are willing to devote to an interview (e.g., Adelman et al., 2000; Brody et al., 2002; Dierking et al., 2004; Falk & Storksdieck, 2005; Jeffery, 1999). Interviews were audio recorded and later transcribed. Field notes were also taken before, during, and after each interview, which

included the approximate time the interviewee(s) spent in the exhibit, behaviors I observed, and reflective notes. Notes were kept with interview transcripts to provide context.

At the close of each interview, I verbally reviewed participants' responses with them. This provided a second opportunity to add to their initial comments (similar to a wait time in formal settings). It also increased the validity of the data through member checking. Member checking involves asking participants to review the data, analyses, interpretations, or conclusions of a study (Creswell, 2007). According to Stake (1995), case study participants are often asked to "review the material for accuracy and palatability" and "may be encouraged to provide alternative language or interpretation" (p. 115). Interestingly, the member checking review yielded some of the most valuable data in the study.

When consenting to be interviewed, participants were also asked for a phone number for the follow-up interview. I attempted to contact all participants several weeks after their visit to the Academy. This timeframe is based on other studies involving ISLE visitors and follow-up phone interviews (Adelman et al., 2000; Dierking et al., 2004; Jeffery, 1999). Jeffery was able to re-interview all of the families who participated in her study, perhaps because of the personal connections she made. Similarly, my goal was to reconnect with as many of my original interviewees as possible.

Quantitative museum studies tend to have relatively low participation rates for follow-up phone interviews (e.g., Adelman et al.; Dierking et al.) but I was eventually able to follow up with 22 study participants (71%). Further, these participants represented all but two (88%) of the original 16 groups. Like Jeffery, my research involved personal conversations with a small number of interested individuals. This may explain why I was more successful in engaging participants for follow-up interviews than some larger studies of museum visitors.

When attempting to contact participants for follow-up interviews, I followed a similar protocol to Dierking et al. (2004). Each participant was called several weeks after the initial interview. A message was left if necessary. Up to two additional calls were attempted.

Visitors who agreed to a follow-up interview were asked open-ended questions from a second interview protocol (Appendix M). This protocol was designed to result in a slightly shorter interview (10-20 minutes), but otherwise asked for similar information. As before, reflective notes were taken during each interview and member checking occurred at the end of each interview. Interviews were audio recorded and later transcribed for analysis.

3.2.6 Data Analysis

During data analysis, I followed a procedure similar to the constant comparative method described by Strauss and Corbin (1998). Despite being developed as an approach to grounded theory, this method can also be appropriate for other types of qualitative research such as case studies. The constant comparative method involves systematically comparing new data to emerging themes and categories. It is an iterative process of interpreting data in which categories may emerge, change, and be subsumed over time. Creswell (2007) offered a description of this method:

The researcher begins with *open coding*, coding the data for its major categories of information. From this coding, axial coding emerges....These categories relate to and surround the core phenomenon in a visual model called the *axial coding* paradigm. The final step, then, is *selective coding*, in which the researcher takes the model and develops *propositions* (or hypotheses) that interrelate the categories in the model or assembles a story that describes the interrelationships of categories in the model (p. 65).

Interviews were transcribed into MS Word with the help of Dragon Naturally Speaking software. Appendix O contains an excerpt of one of the interview transcripts. Using ATLAS.ti, a computer-assisted qualitative data analysis (CAQDAS) program, I began the

process of open coding immediately after the first transcription was complete. A screen shot of ATLAS.ti showing a coded portion of another interview can be found in Appendix P.

There were several benefits to using ATLAS.ti. I was able to code several hundred pages of text without highlighters or scissors, and it was easier to keep track of (and modify) my emerging coding strategy. However, I also used MS Office for some aspects of the data analysis. For example, to compare visitor intentions and behaviors to existing levels of ERBs, I used an MS Excel table to make it easier to sort the relevant quotations.

In an effort to answer this study's research questions, I primarily focused my coding strategy on identifying data which either supported or refuted the propositional statements I made in section 3.2.3. I initially coded direct statements about the exhibit, intentions, and barriers to behavior change. As each additional interview was transcribed, I compared the new data to the existing codes. The coding strategy was continuously modified and refined as the data yielded new ideas. For example, I initially used the code "barrier" to identify any passages relevant to my third research question. Later I split this into two different codes: "internal barrier" and "external barrier." After a number of iterations, I had a list of codes which became the seven categories of barriers I discuss in section 4.4.

I continuously returned to the transcripts that were already coded to look for deeper commonalities between them. I also used my field notes, observations, and document analysis notes to search for additional evidence or alternate explanations for the emerging themes. The final ideas which surfaced were used to answer the research questions and to develop a visual representation of how the *Altered State* exhibit may be contributing to the behavioral intentions and actions of visitors. They were also incorporated into a discussion of the implications of this study for future exhibits.

4. RESULTS AND DISCUSSION

In this chapter, I used the study data to explore how the *Altered State* exhibit influenced environmentally responsible intentions and behaviors in highly engaged adult visitors. The chapter begins with a description of the layout, contents, and intended messages of the exhibit as well as my personal observations of general visitor behavior. Next, it describes visitors who were selected and approached for interviews. The data relevant to each research question are also explored in detail. The chapter ends with a review of the major limitations of this study, including a discussion of how the interview process could have affected participants.

4.1 The *Altered State* Exhibit

The *Altered State: Climate Change in California* exhibit filled the western wing of the main floor of the California Academy of Sciences. Warm colors dominated the exhibit, especially reds and browns. The displays were made primarily from free-standing wooden panels with multiple signs on each panel. Signs typically contained three to four sections of text. The titles in each area were short and attention-getting (e.g., A Tree Pays the Price, California Burning). Almost every sign had at least one image associated with it, and many had two or more. There were significantly more text boxes than pictures in the exhibit.

Much of the information in *Altered State* was communicated via text panels and their associated images. However, the exhibit also contained preserved specimens, live animals, models of innovative technology, and other three-dimensional objects. A few of these items were meant to be touched, such as the giant sequoia tree, the Share Your Ideas board, and the Carbon Café. Continuously looping videos, including interviews with scientists and inventors, played in various locations around the exhibit.

The wooden panels, manipulatives, and specimens were loosely arranged into three sections: Your Changing World: Earth, Your Changing World: California, and Your Changing World: Home. The designers used an open floor plan which allowed visitors to enter and exit these sections from multiple points to the north, west, and east (Appendix Q). The western wall was made of floor-to-ceiling windows and two sets of glass doors which opened to an outdoor eating area. The exhibit was open to the rest of the museum on the eastern side. The southern wall of the museum held the *Building Green* exhibit.

Visitors would pass by *Building Green* if they chose to enter the Your Changing World (YCW): Home section first. However, I observed most visitors entering at the other end through YCW: Earth. This section was on the northern side of the exhibit, opposite the entrance to the museum's cafeteria. It was the closest of the three sections to the main entrance of the Academy. It was also next to the entrance to *Rainforests of the World*, one of the museum's most popular attractions.

4.1.1 Exhibit Sections

Your Changing World: Earth

The most frequently used entrance to YCW: Earth featured a slowly spinning globe showing the planet's geologic features. I heard many museum visitors make comments about recognizable areas as they rotated into view, most often pointing out California or their home state or country. People frequently wanted their pictures taken standing in front of the globe. It is likely this feature captured museum visitors' interest and drew them to the exhibit. They may have noticed the globe while walking past and decided to investigate further. Once inside, people tended to move towards one of four areas of the YCW: Earth section: "Global Impacts", "Dreaming up Solutions", "Carbon in our Lives", or "Taking Action."

The “Global Impacts” area described how the atmosphere and oceans are getting warmer due to human activity. I anticipated this area would interest people because of its central feature, a looping video containing still images upon which phrases such as “we have to act... we have to begin now” and “we can change... we will change” were superimposed. However, this area received much less attention than I had expected. Perhaps people did not notice “Global Impacts” because of its location. It is also possible they rejected the messages in this area, did not find them personally relevant, or were not interested in them.

“Dreaming up Solutions” consisted of a raised platform displaying a bicycle powered by a hydrogen fuel cell, a solar oven designed to replace a cooking fire, and a kinetic playground which generated electricity for a rural school. These inventions seemed to receive a great deal of attention from adult visitors; I often observed them reading signs or watching videos associated with these objects and discussing them with each other. This area also contained a board for people to post their own ideas for addressing climate change on small paper tags (the Tag Board or the Share Your Ideas board). Most adults stopped briefly to read some of the tags but very few added their own ideas. The Tag Board was much more popular with children and often contained silly or inappropriate comments alongside genuine posts of environmentally-minded ideas.

Another popular area was the “Carbon in our Lives” area. Probably the most visited item in this area was a balance which could be manipulated to show one’s carbon footprint in comparison to the average American’s footprint. The balance was meant to be adjusted by sliding weights representing different transportation and home energy usage choices. The message of this manipulative seemed to be that it isn’t possible to get one’s carbon footprint to “balance out” without sliding another weight representing carbon offsets.

When I first visited the *Altered State* exhibit I thought the carbon footprint balance was a clever way to represent the concept that one's environmental impact can never be reduced to zero. However, I found adult visitors tended to make only a brief attempt to utilize the balance and then moved on. Understanding how to properly use it required visitors to read several complex signs and to think of their own choices in unfamiliar ways. For example, it was necessary to determine one's household energy usage in terms of tons of CO₂ per year. The balance was also missing one of the weights which made it impossible to calculate one's footprint with complete accuracy. Thirdly, it was often being misused by children. As a result, people may have found the experience frustrating. It was unlikely that the intended messages were received by all museum visitors.

The "Carbon in our Lives" area also contained several signs explaining the greenhouse effect, global warming, and the role of carbon dioxide in the atmosphere. One of the most striking visuals in this area was a floor-to-ceiling graph of CO₂ levels in the atmosphere over the last 1,000 years. It appeared to draw the attention of many museum visitors. Several Washington Post editorial cartoons which cast a negative light on American attitudes towards climate change were also on display in this area. Based on my observations, these cartoons did not appear to hold visitors' attention for long periods. However, images require less processing time so it is possible people understood their messages even though they moved past them fairly quickly.

"Taking Action" was the fourth area of the YCW: Earth section which tended to attract museum visitors. I observed some people stopping to watch videos about recent community and individual efforts to be more environmentally responsible. Others read the inspirational quotes on display or added money to "yes" or "no" tubes to cast their vote for

bike lanes on the Bay Bridge. Another option in this area, although very few adults elected to participate, was to create a video pledge stating one's personal commitment to environmentally responsible choices.

Your Changing World: California

The section adjacent to the "Taking Action" area was YCW: California, which contained three main areas: "Hot Times Are Coming", "Extinction", and "Risking California's Glaciers." This section explained some ways in which the people, plants, and animals living in the state of California will likely be affected by global climate change. The major idea communicated in this part of the exhibit was that climate change will lead to more wildfires, floods, droughts, and severe weather which will negatively impact habitats, wildlife, and humans.

The part of YCW: California most visitors encountered first was "Hot Times are Coming." This area described how the living things in California will be affected by a hotter, drier climate. Adult visitors appeared most interested in viewing the live display of Northern Pacific rattlesnakes and touching the cross-sectional slice of a giant sequoia tree (two local species whose habitats are being threatened by climate changes). As they did with the globe, people often wanted to have their pictures taken in front of the sequoia tree.

The next area, "Extinction", contained specimens of extinct or endangered species such as the California grizzly bear, the California condor, and the coast fawn lily. The accompanying text panels explained how humans have impacted each species in the past and what effect climate change may have in the future. There was also a video and text panels about mass extinctions and their link to climate change. Most museum visitors spent very little time in the "Extinction" area unless there was a docent giving a talk at the table located

in its center. Interestingly, none of the talks I observed were about climate change or even about extinction; most were about reptiles or sharks.

“Risking California’s Glaciers” described the potential impacts on California’s glaciers and annual snowfall amounts in the Sierra Nevada mountain range. The displays focused on how the state’s water supplies and the local wildlife will most likely be affected by climate change. A significant amount of space was devoted to the American pika, a climate-sensitive mammal native to the mountains in the western United States. Despite containing only text and images, this area received a fair amount of interest from adult visitors.

Your Changing World: Home

The third section of the exhibit was called YCW: Home. As the name suggests, this part explained how climate change might directly impact San Francisco Bay Area residents. The four areas in this section were: “A Sea of Change”, “I Had No Idea”, “Carbon Café”, and “A Rising Tide of Change.” The YCW: Home section seemed to receive the least amount of attention from museum visitors. It is possible people were simply becoming tired of the exhibit by the time they reached it. Alternatively, they may have found this section less interesting.

“A Sea of Change” highlighted the Farallon Islands which are found just off the coast of San Francisco. According to the exhibit, these islands provide evidence of the impact of climate change on marine ecosystems. A large aerial map of the islands covers the floor in this area. People could use a modified binocular tower viewer (similar to coin-operated viewers found at tourist destinations such as the Grand Canyon or the Empire State Building) to interact with certain parts of the floor map. Unlike children, who tended to gravitate toward the viewer, adults seemed more interested in reading the text panels about the islands.

The smallest area, called “I Had No Idea”, consisted of a single display of disposable and reusable items. The signs in this area explained how paper cups, plastic water bottles, chopsticks, and wrapping paper contribute to landfills, and encouraged visitors to adopt more environmentally friendly options. The display was clever and the signs were well written. However, this tiny area faced away from the rest of the exhibit and as a result it seemed to be overlooked by many museum visitors. Most adults passed by it very quickly.

The “Carbon Café” area was one the most visited parts of YCW: Home. The main feature of this area was a manipulative. Like the carbon footprint balance in YCW: Earth, it attempted to show people how they can make changes to their everyday lives to lessen their environmental impact. The Carbon Café consisted of approximately 25 plates of plastic food such as eggs, steaks, fruits, and pastas. Each plate could be lifted by a small black knob to reveal a panel. The panels gave the plate an “emission score” based on its carbon impact and explained how the food contributes to climate change. The panels also provided suggestions for reducing the emission scores, such as switching to organic cheeses, local produce, or free-range meats.

I did observe many museum visitors lifting up the plates of food. However, this area seemed to be significantly more popular with children than adults, perhaps because the fake food looked like toys. This was unfortunate, because the messages beneath the plates were clearly intended for people who make household food purchases (i.e., adults). Most adult visitors spent only a brief amount of time at the Carbon Café or skipped it altogether, possibly because there was a regular stream of children running up to the manipulative, pulling up one or two plates, and then running off.

The final area for most museum visitors was “A Rising Tide of Change.” This area described some of the direct impacts of sea level rise on San Francisco Bay. It also explained the role of the bay as an estuary. It was small compared to the other areas and somewhat separated from the rest of the exhibit, which could explain why it received so little attention. Also, people may have become tired of the subject of climate change or bored with the exhibit in general by the time they reached this area, and as a result passed by it without stopping.

4.1.2 Intended Ideas and Messages

As with any museum exhibit, *Altered State* attempted to impart a number of different ideas to visitors. From personal observations of the exhibit’s contents and an analysis of the photographs and videos of the exhibit, I developed a list of what I believe to be the exhibit’s main messages. However, as learning in a museum setting is deeply personal (Falk & Dierking, 2000) the messages I took away may not have been the same as the interpretations of others.

The strongest message of the exhibit seemed to be: **climate change will have significant impacts on people, plants, and animals**. This message was delivered in many ways throughout the exhibit. For example, some areas explained the potential effects of sea level rise on the people and wildlife around San Francisco. Other parts discussed the impacts of increased sea and air temperatures, including the loss of water and food sources used by millions of Californians. A number of specific species that are in danger as a direct result of climate change were also highlighted. *Altered State* explained how ecosystems will suffer and biodiversity will be lost, both in California and around the globe. Almost everywhere in the exhibit, the Academy seemed to be reinforcing the message that climate change will affect all life on Earth.

All of the other messages seemed to be secondary to this main idea. Still, another relatively strong message in the exhibit seemed to be: **climate change is impacted by our choices, especially our transportation and food choices.** A significant amount of exhibit space in the YCW: Earth section was devoted to explaining how travel impacts our carbon footprint and what choices are better than others in terms of transportation. One of the main manipulatives in the exhibit, the carbon balance, dealt primarily with the idea of reducing one's carbon footprint through different travel choices. A sign above the other main manipulative, the Carbon Café, claimed: "food is 25% of our carbon footprint." The sign also suggested specific changes to food choices, such as eating less meat and buying more locally-grown or sustainably produced food.

A third message appeared to be: **there are many ways to combat climate change.** As just mentioned, the exhibit explained how to reduce individual carbon emissions through lifestyle changes. Additionally, "Dreaming up Solutions" displayed recent inventions designed to lower carbon emissions, such as a solar oven which can replace cooking fires in rural communities and a kinetic playground which uses recess play to provide clean energy to a school. The exhibit also offered examples of ongoing community efforts from around the country, such as urban farming and solar gardens. In the nearby *Building Green* exhibit, the California Academy of Sciences reinforced this message even further by explaining how public and commercial buildings can take action for the environment.

Probably the least explicit message of the exhibit was: **climate change is the direct result of human activity.** There were only a small number of signs in the exhibit related to this idea. However, this message was delivered very clearly in the "Global Impacts" area. For example, during the looping video these words flashed on the screen: "Human activity is

changing Earth's climate. The evidence is all around us, on every continent." Several minutes later, the screen read: "We are the cause of climate change." Hanging next to the video screen was a panel with the statement: "Our use of fossil fuels sends huge amounts of carbon dioxide into the atmosphere, which is warming in response" and "The oceans are paying the price for our energy usage." There were other statements throughout the exhibit which implied that human activity is negatively impacting the planet.

4.1.3 Adjacent Exhibits

Building Green was located across from "Rising Tide of Change" in YCW: Home, on the southern side of the *Altered State* exhibit. This small but significant exhibit described how the Academy building achieved a platinum level of Leadership in Energy and Environmental Design (LEED) certification. Text panels, images, and touchable objects showed museum visitors a number of ways in which the building demonstrates sustainability in its design. For example, people could look at miniatures of the rooftop solar panels or touch the recycled blue jean fibers used to insulate the building.

Immediately adjacent to the *Altered State* exhibit was an impressive 4-story glass dome housing *Rainforests of the World*. Museum visitors often waited in line for significant periods of time to enter this popular exhibit. Inside the dome was a living rainforest from understory to canopy, complete with free-flying birds and butterflies, reptiles, a fish pond, and a cascading waterfall. The rainforest's exit tunnel allowed people to walk directly under the exhibit's fish pond on their way into the aquarium. From the exit tunnel, one could look upwards through the water and see the rainforest canopy five stories above.

4.2 Visitor Interviews

A thorough understanding of the exhibit's contents was an important part of this case study. My observations of general public visitors helped to guide me in selecting study participants. In addition, understanding the intended messages of *Altered State* provided a starting point from which to explore the interview transcripts and helped to validate this study's findings. However, the messages visitors take away from an exhibit are often different from those intended by the museum (Falk, 2005). Consequently, the interview process was critical to revealing participants' impressions and understandings.

4.2.1 Selection Process

I selected potential interviewees using the three main criteria outlined in section 3.2.4. Candidates had to be over the age of 17 and traveling alone or in a group of no more than four people. They also had to appear significantly more engaged than a "typical" museum visitor. Finally, they had to spend a minimum of 10 minutes in the exhibit. I had originally hoped to use an exact method of timing, such as stopwatch, but during my initial observations I discovered this was not an option. Due to the layout of *Altered State*, recording exact start and end times was impossible unless I was willing to give up observing the behavior of potential interviewees. As these observations were a critical part of the selection process, I chose to sacrifice exact timing instead.

The most effective method I found for identifying potential study participants was to wait outside of the exhibit and mark down the start time of adult entrants. I then moved into the exhibit and began to observe their apparent level of interest during the first minute. If they moved too quickly, seemed only slightly engaged, or appeared distracted, I crossed them off the candidate list. I found potential interviewees tended to linger at an early stop near their

entry point. They also moved slowly and deliberately, stopping frequently to read, look, listen, and touch. Although a number of adults displayed these behaviors while in *Altered State*, most candidates moved out of the exhibit prior to reaching the 10 minute requirement. I estimate fewer than 5% of Academy visitors met all three criteria.

Once I had identified a person or group who met the requirements for my study, I tried to anticipate their most likely exit path. When they began to leave, I quickly recorded their end time and approached them with a request for an interview. I found this part of the process was difficult and required some intuition. I discovered a small window existed where people were getting ready to leave the exhibit but still present in the experience. If I missed this opening, those I approached were less inclined to participate in the study.

4.2.2 Participants

I conducted a total of 16 face-to-face interviews with 31 adults. Individuals who consented to be interviewed are listed below using pseudonyms to protect their identities:

Group 1: Eleanor - woman from CA

Group 2: Gavin - man from IN

Group 3: Jasper - man from MA

Group 4: Amber and Declan - couple from CA

Group 5: Ashley and Benjamin - couple from CA

Group 6: Bridget and Cole - couple from NV

Group 7: Cherie and Thomas - couple from CA

Group 8: Diane and Nathan - couple from CA

Group 9: Lilly and Terry - couple from CA

Group 10: Naomi and William - couple from CA

Group 11: Richard and Travis - friends from NJ

Group 12: Rosalind and Kylie - friends from CA

Group 13: Vivian and Ryan - couple from CA

Group 14: Zoey and Dylan - father from AZ and daughter from CA

Group 15: Lauren, Andrew, and Carter - couple from IN and son from IN

Group 16: Sophie, Alexander, and Jacob - couple from CA and father from NJ

I approached a total of 22 adult groups, but six were not willing to be interviewed. Three of the rejections occurred on the first day, possibly because I was not as adept at anticipating the right moment to ask for an interview. The most common reason given for not participating was lack of time. Some who declined had other engagements; for example, several groups said they had already purchased tickets for a planetarium show that was about to start.

Of the 31 participants, 29 were first-time visitors to *Altered State*. Diane and Nathan (group 8) were the only two participants who had seen the exhibit before. The face-to-face interviews averaged about 14 minutes in length. Group members were interviewed together, as they had experienced the exhibit together.

Twenty-two people (71%) also participated in follow-up phone interviews. The only two groups I was not able to speak with again were Groups 4 and 8; in other words, 88% of groups were represented by at least one person in the follow-up interviews. The individuals who were re-interviewed are listed below:

Group 1: Eleanor (CA)

Group 2: Gavin (IN)

Group 3: Jasper (MA)

Group 5: Ashley and Benjamin (CA)

Group 6: Cole (NV)

Group 7: Thomas (CA)

Group 9: Terry (CA)

Group 10: Naomi and William (CA)

Group 11: Richard and Travis (NJ)

Group 12: Rosalind and Kylie (CA)

Group 13: Vivian and Ryan (CA)

Group 14: Zoey (CA)

Group 15: Lauren, Andrew, and Carter (IN)

Group 16: Sophie (CA) and Jacob (NJ)

Only one person reported visiting the Academy again. Rosalind, a member of group 12, visited an additional three times between the two interviews. Follow-up interviews averaged 11 minutes long. Each person was interviewed separately, even if group members shared a phone number. This was primarily to eliminate any confusion about who was speaking.

4.2.3 Demographic Information

Although my interviewees were not meant to be a representative group, I felt it was still worthwhile to compare them to the Academy's 2011 visitation report. The report was generated using 1,372 take-home surveys (Table 1). This method of data collection may not have resulted in a truly representative sample of Academy visitors as it was dependent on people mailing the surveys back. However, the report contained the best information available about the demographic characteristic of general public visitors.

Table 1. Demographics of Study Participants and General Public Visitors

	Interviewees		General visitors	
	n	%	n	%
Gender				
Males	16	52%	487	36%
Females	15	48%	885	65%
Age				
18-29 years	8	26%	Average age of adults: 45 years	n/a
30-39 years	6	19%		
40-49 years	5	16%		
50-59 years	8	26%		
60+ years	4	13%		
Education Level				
Grad/Professional	12	39%	631	46%
Undergraduate	9	29%	521	38%
Some college	8	26%	165	12%
H. S. diploma	1	3%	27	2%
Other	1	3%	27	2%
Ethnicity				
African American	0	0%	14	1%
Asian/Pacific Islander	2	6%	247	18%
Latino	1	3%	55	4%
White (non-Hispanic)	25	81%	974	71%
Other	3	10%	82	6%
Home State				
California	20	65%	1207	88%
Other	11	35%	165	12%
First Visit				
Yes	29	94%	700	51%
No	2	6%	672	49%

Over half (65%) of the Academy's respondents were female, compared to slightly fewer than half (48%) of my interviewees. My study participants tended to be either 18-29 years of age (26%) or 50-59 years of age (26%), followed by 30-39 years of age (19%) and 40-49 years of age (16%). The smallest age group was over 60 years of age (13%). As the

average age of general adult visitors to the California Academy of Sciences is 45 years, it is interesting that the 40-49 age group was the second smallest in my study.

Twelve participants (39%) reported their highest level of education as a graduate or professional degree and 29% reported having an undergraduate degree. Ninety-four percent of study participants had at least some college. The majority of participants (81%) identified themselves as White, although two participants were Asian and one was Latino. No interviewees marked their ethnicity as African American or American Indian. This was not surprising, as these two groups make up less than 2% of the Academy's annual visitors. The remaining three participants marked their ethnicity as other. The distribution of education levels and ethnicities in this study's participants was similar to the Academy's general public visitors in 2011 with one exception; there were significantly fewer Asian participants in my study than I would have expected based on the Academy's report.

All but two of the 31 people I interviewed (94%) had never visited the museum before, whereas only 51% of Academy survey respondents were first-time visitors. Also, only 65% of my study's participants lived in California, compared to 88% of general public visitors. It is possible first-time visitors and out-of-state visitors were more likely to meet my study criteria. Perhaps frequent Academy visitors spent less time in the *Altered State* exhibit or seemed less interested in the content because they had seen it more than once.

4.2.4 ERB Rating Groups

In addition to demographic information, participants were also asked to share the types of environmentally responsible actions they were already taking. Knowing their existing ERBs helped me evaluate their responses to my questions. For example, an individual who claimed *Altered State* had little or no effect on her might have responded that way because she

is not very environmentally responsible. Conversely, she might be very responsible but already performing as many ERBs as she is willing to. Knowing an interviewee's past actions gave me a context from which to evaluate the impact of the exhibit on her future actions.

I organized participants' responses into six categories of action. Category 1 included actions related to reducing resource consumption, such as conserving energy or water. Category 2 involved reusing available materials, such as re-usable water bottles and cloth bags. Waste management choices were included in Category 3, such as composting and recycling. Alternate transportation choices, such as taking public transportation, carpooling, and biking, were grouped into Category 4. Alternate food choices, including shopping at farmer's markets and reducing or eliminating meat consumption, fell into Category 5. The final category, Category 6, was for miscellaneous actions such as supporting conservation organizations or convincing others to be more environmentally responsible.

These categories of action were emergent rather than pre-determined; as such, they did not necessarily align with others found in the literature. Interviewees received an ERB rating of low, medium, or high based on how their environmentally responsible actions were distributed across the six categories. Participants who performed more ERBs were rated more highly, as were those whose actions were spread across more categories. Ratings were based on individual responses, so participants from the same group did not automatically receive the same score. On a few occasions I adjusted a participant's ERB rating following the second interview, as people sometimes revealed additional information they had not mentioned during our first conversation. These three ERB rating groups were used during data analysis. Specifically, I wanted to see if differences existed between the groups in terms of intended and actual ERBs, barriers to change, or comments about the exhibit's design or messages.

Interestingly, participants were evenly distributed across the three groups. Ten people were in the low ERB group, 11 fell into the medium ERB category, and 10 demonstrated high ERBs. Approximately 70% of the people in each group reported having a college education. The groups were also almost equal in terms of gender, although the medium group had slightly more men (65%) than women (35%). Older participants tended to be in the high ERB group. In fact, this group included only one participant under the age of 40. The medium group was the youngest with seven people under 40. However, the low ERB group had a relatively even distribution of ages, which suggested that age was not necessarily linked to the performance of environmentally responsible actions.

Home state appeared to be the only notable difference between the groups. Only 40% of the low ERB group members lived in California, compared to more than half (65%) of people in the medium ERB group. Nine members (90%) of the high ERB group were from California. Perhaps Californians are generally more environmentally responsible than people from other states. On the other hand, CA residents who are environmentally responsible may simply have been more likely to meet the study criteria than CA residents who are not.

With the exception of home state, there seemed to be no significant trends between the ERB groups related to demographic variables, including age, gender, or education. This supported Hines et al.'s (1986/1987) finding that demographic variables are not strong predictors of environmentally responsible behavior. A lack of diversity prevented other variables (i.e., ethnicity and number of visits) from being compared between the groups.

4.3 Intended and Actual Behaviors

Statements related to the intention to perform environmentally responsible behaviors were made by members of all three ERB rating groups. These responses fell into three distinct

categories. Some participants simply said they were thinking about making changes in the future. In other words, they talked about change in a very general way. Other interviewees named specific future actions they wanted to do, such as driving less or recycling more. A third group claimed they had no plans to change their ERBs. Actual changes in behavior were also seen in a small number of people across all three groups.

4.3.1 Responses by Rating Group

Low ERB Group

Half of the individuals in the low ERB group discussed changing their behavior. A few named specific actions they thought they might take, but most talked about change more generally. For example, Dylan shared during his first interview:

Dylan: Maybe not anything specific from here today but in general, just having done this... it certainly did raise my consciousness or awareness about the issue in general, and then my, I think, future likelihood of adopting more green-friendly behaviors.

Unfortunately I did not have the opportunity to re-interview Dylan. Other interviewees in the low ERB group made comments which were not focused in any particular direction, even when mentioning certain actions. For example:

Jacob: I guess I thought I was being smarter to fly, I think maybe I'm not... I'm trying to think of what it is I would do next to improve. We could turn the thermostat down more, or I could decide to stay over, or something like that.... (Note: this comment referred to "staying over" in the city where he works; currently, Jacob makes a weekly commute by plane)

During his follow-up interview, Jacob indicated he had not made any changes to his behavior. Still, his thoughts about ERBs had clearly been influenced by the exhibit:

Jacob: I think the thing that stuck in my mind for such a long time was what the impact of flying was on my footprint. It was really much higher than I expected. I thought I was doing the world a favor, because I'm in there with a hundred other people, and I thought, "How can I be causing more problem by being in a commuter vehicle, in a sense, than me driving?"

Jacob and Dylan were not the only members of the low ERB group to say the exhibit made them think more about the effect of their actions. During her follow-up interview, Terry shared the exhibit had made her think more about her food and transportation choices.

Terry was also one of the few members of the low ERB group to make a change to her actions. She reported that she began carpooling more frequently after viewing the exhibit. Similarly, Cole shared that he had started to recycle a bit more since his trip to the Academy, and had also started to make efforts to consolidate his car trips. Interestingly, neither Cole nor Terry had previously expressed any intention to make these changes.

The other half of the interviewees in the low ERB group felt the exhibit would not impact their future actions. The reasons they gave for this response varied. Some described physical barriers to change. For example, several people talked about recycling being difficult in their communities because there is no curbside pickup. Others talked about mindsets that could prevent change. For example:

Lilly: As an adult, I feel like I am pretty set in my ways. To know that something helps, but then to actually put it into practice, those are two very different things.

Even though Lilly did not feel the exhibit would impact her actions, she still described it as influencing her thoughts. In this way, her response is very similar to others in this group. Overall, about half of the low ERB group talked about general changes to their thoughts or plans regarding behavior. Actual behavior changes seemed to occur without prior planning.

Medium ERB Group

Similarly to the low ERB group, about half of the people in the medium ERB group discussed changing their behavior. However, instead of referring to change in a general way, this group was more likely to identify specific ERBs they thought they might do differently in

the future. For example, Kylie and Rosalind each identified changes they thought they might make in the future:

Kylie: I probably won't eliminate meat consumption but at least maybe, be more mindful where the meat comes from (to) decrease some of the impact.

Rosalind: I think being more mindful of my driving... and also there was a good reminder about washing all your clothes in cold water... that's something I was reading. I was like, "oh yeah, I need to do that."

When I spoke with Kylie again, she shared she had been trying harder to buy local food since visiting the exhibit. When I re-interviewed Rosalind, she too reported an influence of the exhibit on her actions:

Rosalind: I've been really trying to be aware of using our smaller vehicle, the one that's way more efficient with gas on days when one of us is going to be making longer commutes and that wasn't really something I did before.

...It's actually something I'm doing now, washing my clothes with cold water. Instead of just assuming that I have to do everything with warm water, I've actually kind of changed my laundry habits lately as a result of (the exhibit).

Another interviewee who spoke about specific changes was Carter, a college student visiting with his parents. During his face-to-face interview, Carter talked about a personal desire to help make alternate fuel sources more accessible to the public:

Carter: When Dad mentioned the alternative energy, that hydrogen fuel and electricity, it got me thinking a lot about it, 'cause I read a lot of things about it and... I liked the physics part behind it. It just makes me think about how to mass-produce the hydrogen energy, because it's very difficult right now.

During our phone call, he reiterated:

Carter: It was definitely interesting when they talked about alternate fuel, and I would kinda like to help out with that... The hydrogen fuel, I can definitely see a future in that.

Of course, he could not have made this change by the time the follow-up interview occurred.

Still, this exhibit might someday have a significant impact on Carter's life.

The other half of the people in the medium ERB group said the exhibit had no direct effect on them in terms of environmentally responsible actions. As with the low ERB group, some talked about barriers such as lifestyle or finances. Other participants claimed the exhibit positively reinforced their existing beliefs and actions but did not convince them make additional changes. For example:

Jasper: I mean, its, for me, it's just sort of reminding me of some things that I've already known in this case, and brought it maybe to the forefront of my attention, but nothing that, I'm like, gonna go home and say, "I'm not doing this, I should be doing this," that I haven't already taken into account.

Nathan voiced a similar opinion. Overall, about half of the members of the medium ERB group seemed to be inspired to change as a result of their visit. The few who did make actual changes had previously identified the exact behaviors they wished to change. The other half of this group primarily found the exhibit to be reinforcement for their existing ERBs.

High ERB Group

Interestingly, participants in this category were the most likely to state they “should be doing more” for the environment. I am not sure why this was the case. Perhaps these individuals perform more environmental responsible actions than members of the other groups because they have a persistent desire to do more. Or there may be more social pressure to have this attitude in California. As mentioned in section 4.2.4, this group was made up almost entirely of California residents. It is also possible they simply felt more compelled than other groups to say what they thought I wanted to hear.

Despite these comments, only a handful of individuals in this group seemed to think the exhibit would impact their behavior. Those who did talk about intentions to change tended to do so within the context of refining their existing ERBs. For example:

William: I do what I consider to be a considerable amount but I don't think I do enough. And so it just kind of reinforces that maybe I need to look at ways that I can do better.

During his follow-up phone interview, William shared that he went from walking to the gym (instead of driving) about half the time to walking about 95% of the time. Another participant shared a similar sentiment:

Thomas: ...it was more sort of the repetition of hearing it again, and sort of strengthening our efforts to be more discerning about the things we do... I don't know that we've really changed anything, like, any additional, I think it's more we try to strengthen some of the things that we already do.

Several weeks after his visit to the museum, Thomas said he was continuing to increase his efforts to consolidate household trash into fewer bags and to recycle everything he can.

Most of the people in the high ERB group believed exhibit would not change their behavior. They were the most likely group to state the exhibit would be more valuable for other visitors than it was for them. Individuals often said they knew considerably more than the general public; they also stated they were already performing significantly more ERBs than other people.

In fairness, there may not have been many valuable suggestions for the people in this group. Members of the high ERB group did appear to be more environmentally responsible than “average” Americans. For example, one interviewee shared that his eventual goal is to produce zero waste from his household. Another said he will not buy products unless the packaging can be recycled. A third captures the water that would be wasted by pre-heating the shower and uses it to flush her toilets.

4.3.2 Summary of Findings about Behaviors

The patterns which emerged relative to intentions and behaviors across the three ERB groups are summarized in Table 2.

Table 2. Intentions and Actual Changes to ERBs

Participant	Intentions				Actual Changes
	General changes	Specific changes	Refinement of existing ERBs	No plans to change	Specific changes or refinements
Low ERB Group					
Bridget				✓	--
Cole				✓	✓
Declan		✓			--
Dylan	✓				--
Jacob	✓				
Lilly	✓				--
Richard				✓	
Terry		✓			✓
Travis				✓	
Zoey				✓	
	3	2		5	2
Medium ERB Group					
Amber				✓	--
Andrew				✓	
Carter		✓			
Diane				✓	--
Eleanor		✓			
Jasper				✓	
Kylie		✓			✓
Lauren				✓	
Naomi		✓			
Nathan				✓	--
Rosalind		✓			✓
		5		6	2
High ERB Group					
Alexander				✓	
Ashley				✓	--
Benjamin				✓	
Cherie		✓			--
Gavin				✓	
Ryan				✓	
Sophie				✓	
Thomas			✓		✓
Vivian				✓	
William			✓		✓
		1	2	7	2

Note: "--" denotes actual changes unknown (participants not re-interviewed)

Five of the 10 people in the low ERB group thought the exhibit might impact their actions in the future. However, this group more often talked about wanting to change in a general way, or about becoming generally more aware of their actions. Five of the 11 members of the medium ERB group thought the exhibit might change their future actions. Unlike the low group, these participants specifically identified new ERBs they wanted to perform. Only three of the 10 people in the high ERB group felt the exhibit might influence their future actions. These individuals tended to talk about refining existing actions rather than taking new actions.

Half or more of the interviewees in each group felt the exhibit would not change their future actions. Those in the lowest category tended to give reasons why they could not adopt more ERBs. People in the medium group tended to say they already performed environmental actions and the exhibit did not convince them to do more. Members of the high ERB group were the most likely to say the exhibit would not impact them personally but would be beneficial for others.

Overall, those who were already taking responsible actions seemed the least inspired by the exhibit. People who performed the fewest environmental actions were slightly more motivated to change, but their intentions and behaviors tended to differ. Individuals who were “middle of the road” as far as environmental responsibility were the most likely to intend to use suggestions from the *Altered State* exhibit, and to follow through with those intentions.

4.4 Barriers to Behavior Change

Participants often wanted to explain why they could not be more environmentally responsible. I had anticipated asking about barriers to change during the follow-up interviews, but people seemed eager to offer them up almost immediately. Comments about barriers

appeared to fall into two broad categories: external and internal. External barriers exist physically in the world (e.g., the cost of paying for trash pickup), while internal barriers are primarily in the mind (e.g., beliefs about composting). Members of the three ERB groups mentioned internal and external barriers, but the number and types of comments differed.

4.4.1 External Barriers

Twenty-four people (77%) mentioned external barriers to change. The external barriers most commonly identified by participants were: money, job responsibilities, consumerism, time, convenience, community support, and a need for sustainable alternatives. Comments about these barriers sometimes overlapped; for example, a participant sometimes talked about a lack of money and a lack of time related to the same ERB. As a result, there were a number of ways to present the findings in this section. I decided to arrange statements into three larger categories: “money”, “culture”, and “support.”

Money

Lack of money was a frequently mentioned external barrier. A number of participants claimed eco-friendly products (e.g., sustainably produced foods, alternative energy vehicles) are preferable but too expensive. Also, several interviewees mentioned they do not recycle because there would be an extra cost involved. Thomas described the money barrier as a double-edged problem:

Thomas: ...even the recycling and the food are really dependent on the income bracket that people are in. That's really disheartening because people who don't make much money don't buy... they buy packaged food. That's more packaging. Because those are the foods that are the cheapest.

In other words, people with less money tend to be less involved with recycling efforts because of the extra cost, while at the same time tend to create more trash because the least expensive food items are often the most heavily packaged.

The need to make money (i.e., to work) was another barrier that was often mentioned. People sometimes seemed more defensive when discussing this barrier, perhaps because they feel they have less choice and control over their job situation than they do over other aspects of their lives. For example, Ryan said he must still travel for professional reasons, despite the exhibit making him more aware of how much flying impacts the environment. Similarly:

Travis: I think so much of the country is in our position... I'm an attorney, and my job every day is drive around to various court appearances and lawyer's offices... I just burn tons and tons of emissions, I run up the mileage on my car, I hate it, but there's just no option for me. That's my job. That's who hired me in a terrible economy, so what am I supposed to do?

Travis' explanation may illuminate a common barrier for many Americans, a fundamental conflict between the need to make money and the desire to be environmentally responsible.

Culture

Money and employment are also linked to certain aspects of American culture. A number of participants talked about being consumers, using statements such as, "I have to admit though, we are consumers", "Consumerism definitely has a lot to do with the whole problem", and "We try to be pretty conscious even though we are consumers." One person talked about consuming as a by-product of having extra money:

Ashley: I think the recession's really been good for the environment... It's bad when people lose their jobs, it's bad when people don't have enough money... but there's been less business travel, less flying around, less urgency, less consumption.

Some interviewees spoke with an air of acceptance, but most seemed to suggest that consumption is a negative aspect of American culture. All of the comments implied that a culture of consumerism is fundamentally at odds to performing ERBs.

In addition to being a nation of consumers, America is also a fast-paced society. Lack of time was another commonly mentioned barrier. Several interviewees talked about wanting to do more ERBs but not having the time:

Terry: Whether it's planting trees or any of that kind of stuff, I think if I had a little bit more time on my hands I would love to get into stuff like that, giving back to the community and helping in whatever way I can, but right now in my life I just don't have the time for that.

Other participants explained certain ERBs, such as taking public transportation or walking, are desirable but do not fit into their busy lives because they require too much time.

The expectation of convenience is a third barrier linked directly to American culture. When talking about why they can't or don't perform ERBs, multiple participants mentioned the need for convenience. People also brought up convenience as a reason to continue performing actions which have negative consequences for the environment:

Benjamin: ...the reason people drive is because it's easier, it's convenient. So basically that's the story of consumerism... it's easier to just use plastic and throw it away... the way people used to live, there was probably a lot less trash, because they used everything, you know?

In addition to seeing convenience as a barrier, interviewees also mentioned it when making positive comments about community systems. For example:

Jacob: Where I live, we recycle every week and the way they set it up, they make it very convenient... one may put everything in one recycle container thing, so paper, glass, plastic, everything goes in one.

Comments like these suggest that, for Americans, convenience is an important consideration when deciding whether or not to perform environmentally responsible actions.

Support

Not all community systems were described positively by participants. In fact, a general lack of societal support for ERBs was frequently cited barrier to change. A number of

interviewees said they found certain environmentally responsible actions more difficult because businesses or governmental agencies do not provide support for them:

Bridget: The community that we live in is not doing well on the promoting of recycling. Our garbage department... they can't get it together and have different bins. Nobody wants to pick up the thing. If you are a recycler where we live, you have to do all the dividing up, and you have to get in your car and drive it to the place...

By far the most common criticisms were about recycling programs, but others also mentioned not being able to avoid unwanted packaging or a lack of reliable public transportation.

A similar barrier, voiced primarily by members of the high ERB group, was a lack of sustainable alternatives for technologies or services:

Thomas: ...my biggest peeve is with the lack of a solar initiative... governmental funding or state funding... for people to be able to install that on their houses. Because I've read of houses that are in Washington State that are "off the grid", and when I think about how rainy and how cloudy it is in Washington State and Oregon, and I think, "this is ridiculous." Somebody can make that work... what are we doing here? In Southern California... 320 days of sunshine a year or even more, why is there not a bigger push for that?

I considered a lack of green alternatives to be a lack of community support for ERBs, because even those who are very environmentally responsible can only do so much on their own. Also, a lack of alternatives can keep people from making changes:

Vivian: ...we have considered buying a hybrid, but we've also been told that the batteries of hybrid cars are extremely toxic. If people don't dispose of these batteries properly they're gonna do much more damage than good... so we haven't quite gone the way of hybrid cars.

Altered State does not address issues like these, which may have been one of the reasons members of the high ERB group felt the exhibit was less useful to them personally.

External barriers were discussed by approximately the same number of people in each ERB group, but the number of comments differed. The total number of comments made by

people in the medium and high groups was about the same, while members of the low ERB group made almost twice as many statements overall. In other words, people in the low group tended to talk about external barriers with greater frequency.

Perhaps people in the lowest ERB rating group truly had more external barriers in their lives; as a result, they performed fewer environmentally responsible actions. Another possibility is that these individuals experienced the same barriers as others, but were more affected by them. They may have been less able (or believe they are less able) to overcome external barriers. Some participants in the low ERB group talked about a lack of guidance in “taking the next step” to change their behavior, suggesting they may simply be unaware of how to overcome barriers to change. The low group also seemed slightly more concerned about lack of community support than with money or cultural barriers.

4.4.2 Internal Barriers

Unlike more tangible barriers such as money or culture, internal barriers to behavior change proved to be significantly more difficult to categorize. All of the barriers discussed in this section are beliefs, meaning they are ideas thought to be true by the people who hold them. More specifically, they are beliefs which serve as obstacles to behavior. My purpose in describing these barriers was not to argue the validity of any participants’ ideas, but to present them as additional reasons they gave for not performing ERBs.

Internal barriers were less likely to be discussed by participants; in fact, only 13 (42%) made comments about internal barriers. Further, eight of these 13 people were members of the low ERB group. Perhaps interviewees felt less comfortable talking about their personal beliefs about change, especially if those beliefs were not in favor of performing environmental

actions. Alternatively, fewer people may have experienced internal barriers, especially in the medium and high ERB groups.

I categorized internal barriers using first-person statements which identify underlying beliefs. It is important to note that interviewees almost never made these declarations themselves. These statements reflect a layer of interpretation added to participants' actual words. I organized comments into four statement categories: "I don't want to change", "I don't know how to change", "I don't need to change", and "I don't think change matters."

I don't want to change

One internal barrier expressed by interviewees was an unwillingness to change. This internal barrier seemed to be primarily experienced by low ERB group members. Only one person from the medium group made a comment of this type. Based on their interview comments, no one from the high ERB group appeared to experience this barrier.

While discussing experiences related to the Carbon Café, two different participants proclaimed: "I can't give up my steak!" Several used the phrase "I am set in my ways" when talking about why they did not anticipate changes to their behavior. In addition, some interviewees made comments which suggested they believe it is socially unacceptable to perform too many ERBs. For example:

Terry: Of course we do daily things, not leaving lights on, or running water all the time, and just being aware of that kind of stuff. But other than that, we don't go too crazy, or we don't go to the hippy end of the spectrum, where we're living in a forest or anything...

Another said he is doing as much as he can "without going to extremes." These individuals seemed to be concerned about the possibility of no longer fitting in with established social norms for environmentally responsible behavior.

I don't know how to change

A similar pattern of responses was seen in the second category of internal barriers; specifically, all but one comment of this type came from members of the low ERB group. Again, the one exception was from the medium ERB group and no members of the high ERB group made comments about not knowing how to change.

Many of the statements which fell into this category were generalized concerns. For example, a number of people said “change is hard.” I interpreted this comment to mean interviewees did not know how to approach making changes. Perhaps they felt they lacked the knowledge or the skills to become more environmentally responsible. However, it is possible some people made this statement as an excuse rather than truly experiencing an internal barrier related to knowing how to change their actions.

Some comments in this category were about specific ERBs. For example, one interviewee said she would like to become more involved with community service projects but did not know how to begin. Another was unsure how to choose the most environmentally responsible foods. Interestingly, her visit to the Academy actually caused her some confusion:

Eleanor: I've gone to Monterey Bay aquarium several times, and they're always telling you the types of fish to eat or not eat... so then, you're like, okay well here, that was actually on the higher level, the tuna or whatever it was, so it was like... hmm, okay, well, so how do you decide then what's the best choice?

During our follow-up conversation, Eleanor reiterated that the Academy had not helped her to know what the most environmentally responsible food choices were:

Eleanor: I also remember feeling confused about how to know the difference between carbon impact versus other industries' impact, and how to make a good choice. In terms of... everybody's got their agenda and I was left feeling like I didn't really know which one was best to choose, then.

Her visit may have reinforced the value of making environmentally conscious decisions, but the specific suggestions in the exhibit did not align with what she had learned elsewhere. Based on our follow-up conversation, I believe she will continue to rely on her existing knowledge about which types of fish are acceptable to eat.

I don't need to change

This internal barrier was the only one not voiced by anyone in the low ERB group. At the same time, it was the only internal barrier consistently mentioned by people who were already performing some level of ERBs. Only five people (two from the medium ERB group and three from the high ERB group) said anything related to internal barriers to change, and all of these individuals made comments which fit into this category.

All five also pointed out that they were already making environmentally responsible choices. It is possible the performance of ERBs actually created a belief barrier for these individuals. Some people may have felt they were already doing “enough.” One person from the medium ERB group said the exhibit would have very little impact on her because she was currently “living a pretty environmentally aware existence.” Others seemed to feel they had already made acceptable sacrifices. For example, one member of the high ERB group said his slightly smaller SUV meant he was not as “bad” as he could be. Perhaps individuals reach a personal threshold relative to the number of environmentally responsible actions they are willing to do, or feel less obligated to perform additional ERBs once they are already doing something for the benefit of the environment.

I don't think change matters

The low ERB group was the only group to make statements which could be placed in this category, although comments varied widely. One person stated that in general, human

actions matter very little when looked at from the perspective of geologic time. Interestingly, he said these ideas were partly a result of his visit to the Academy. Several areas of the museum outside of the *Altered State* exhibit may have reinforced his belief in the unimportance of his actions. Specifically, these areas provided evidence that humans have only been on Earth for a very short time when compared to the entire history of the planet.

Two other participants also seemed to feel that individual actions do not matter. Both indicated they do not drive alternative fuel vehicles because there are not enough other people driving them. Travis explained why he doesn't have a hybrid car:

Travis: Just having a couple of “do-gooders” buy hybrids is insufficient in my opinion. That's why I don't own one, because if one out of every 100 people owns one, it's such a minimal, minimal (impact).

During the follow-up interview, Richard gave a similar reason for not driving an electric car. Both Travis and Richard also spoke about the need for ERBs to be mandatory around the globe. They stated their individual actions would not matter unless everyone on the planet was equally environmentally responsible. As these two participants were visiting the museum together, they may have influenced or reinforced each other's views about individual actions.

4.4.3 Summary of Findings about Barriers

Many participants discussed barriers to behavior change, both internal and external. Responses varied widely between individuals, but certain trends emerged about the types of barriers people talked about. These patterns are summarized in Table 3. A commonly mentioned external barrier was a lack of money, especially in the sense that certain ERBs were too expensive. The money barrier was often linked to comments about working. A number of participants said their jobs, necessary to acquire the money to maintain their lifestyles, resulted in being less environmentally responsible.

Table 3. Barriers to Behavior Change

Participant	External Barriers			Internal Barriers			
	Money	Culture	Support	I don't want to change	I don't know how to change	I don't need to change	ERBs don't matter
Low ERB Group							
Bridget		✓	✓		✓		
Cole	✓		✓				✓
Declan		✓		✓	✓		
Dylan			✓				
Jacob	✓	✓	✓		✓		
Lilly				✓			
Richard	✓		✓				✓
Terry	✓	✓	✓	✓	✓		
Travis	✓		✓				✓
Zoey			✓				
9 people; 17 comments				8 people; 10 comments			
Medium ERB Group							
Amber							
Andrew		✓	✓	✓		✓	
Carter	✓		✓				
Diane		✓					
Eleanor					✓	✓	
Jasper							
Kylie		✓					
Lauren	✓						
Naomi		✓					
Nathan							
Rosalind	✓		✓				
7 people; 10 comments				2 people; 4 comments			
High ERB Group							
Alexander						✓	
Ashley		✓					
Benjamin		✓	✓				
Cherie			✓				
Gavin	✓	✓	✓				
Ryan	✓					✓	
Sophie							
Thomas	✓		✓				
Vivian			✓			✓	
William		✓					
8 people; 12 comments				3 people; 3 comments			

Cultural barriers were also frequently mentioned. People expressed that living in a culture of consumerism made them less environmentally sound. They stated both time and convenience were important to their decisions about whether or not to perform ERBs. The most commonly mentioned external barrier was a lack of community support for environmentally responsible actions. Many individuals criticized their communities for failing to support their efforts. Some seemed to feel that businesses or governmental bodies did not offer them sustainable alternatives.

Internal barriers were discussed less often than external, but participants did voice a number of beliefs which might have served as barriers to change. The most common was the sentiment that individuals did not want to change their behavior. Others may have wanted to change, but it appeared they did not know how to do so. Some, especially those who were more environmentally responsible, seemed to feel they did not need to change because they were already performing enough ERBs. A small number of people felt that individual actions do not matter.

People in the low ERB group were the most likely to discuss barriers. Nine out of 10 talked about external barriers, and eight revealed they had internal barriers as well. Members of the low group made about twice as many comments about barriers as the other two groups. The external barrier most often mentioned by this group was lack of societal support and the most common internal barrier was “I don’t want to change.” Every barrier was mentioned by the low ERB group with the exception of “I don’t need to change.”

The trends in the other two ERB groups were somewhat different from the low group, but similar to each other. Seven of the 11 people in the medium group mentioned external barriers, but only two talked about internal barriers. Eight out of 10 members of the high ERB

group brought up external barriers, but only three mentioned internal barriers. All three ERB rating groups seemed to experience external barriers. However, only the low ERB group appeared to experience a significant number of internal barriers. The only internal barrier mentioned with any consistency by the other two groups was the belief that they did not need to change, perhaps because they felt they were already doing as much as they could.

As discussed in section 4.3, the medium ERB group seemed to be the most receptive to the exhibit's suggestions. Although the people in both the medium and high groups had fewer internal barriers than those who were not very environmentally responsible, it is possible the members of the medium ERB group were slightly more motivated to overcome external barriers than people who were already doing a lot.

4.5 Exhibit Design

During my observation days I noticed adult museum visitors tended to stop at certain places in *Altered State* even if they did not otherwise seem particularly interested in the exhibit. The areas which seemed to draw the most attention from general adult visitors were the Farallon Islands display, the animals (especially the snakes), the sequoia tree, the carbon footprint balance, the graph of atmospheric carbon levels in the "Carbon in our Lives" area, the editorial cartoons, the inventions in the "Dreaming up Solutions" area, and the globe. All but three of these areas were part of Your Changing World: Earth.

My observations of adult visitors tended to align with Randi Korn & Associates' summative evaluation of the exhibit. For example, the evaluation also found that visitors spend the greatest amount of time in the YCW: Earth section (RK&A, Inc., 2009). However, the report listed the Carbon Café as one of the most popular areas of the exhibit. In contrast, I found most adult visitors passed over this manipulative. This discrepancy was likely due to

differences in the populations being observed. The 2009 evaluation included all visitors older than eight, but I focused my observations on visitors who appeared to be at least 18.

Potential study participants (i.e., highly engaged adults) seemed more interested in the Carbon Café than general adult visitors. I noticed they also spent more time watching videos, reading signs, and touching manipulatives than other adults, and seemed generally more interested in the content. They also tended to spend less time at the Farallon Island display and the globe than general visitors. During the interviews, participants talked most often about the wildlife displays, the Carbon Café, and parts of YCW: Earth, including the carbon balance, the cartoons, the carbon graph, the glacier images, and the inventions.

4.5.1 Parts of the Exhibit

Your Changing World: Home

Participants talked about the Carbon Café more than any other part of YCW: Home. Unlike general adult visitors, who might have lifted up one or two plates of food before moving on, I observed a number of different interviewees lingering there. In fact, a few participants spent the majority of their time in the exhibit interacting with this manipulative. Eleven participants (35%) talked about the Carbon Café during their interviews. Most of these were from the high or low ERB groups.

Individuals almost never referred to the Carbon Café by name. People tended to call it “the plates of food” or the “food display.” This was curious because the title above the manipulative is one of the largest in the exhibit. People’s interest in the movable parts of this display may have distracted them from the signs in this area. This could explain why interviewees tended to talk less about the messages from the signs and more about the plates themselves or the carbon impact of certain foods (found on the panels beneath the plates).

The Carbon Café did seem to have an influence on some participant's intentions, especially in the low ERB group. For Terry, it appeared to strengthen her existing interest in making healthier food choices, such as organic, free-range, and local. Others were presented with new options for ERBs by the Carbon Café. For example, Declan shared that “*everything involving the food... that was new to me.*” He also stated he might try to follow the exhibit's suggestion to “*reduce the meat a little bit.*” Unfortunately, I was unable to follow up with him to see how his intentions compared to his actual future actions.

Your Changing World: California

The plant and animal displays were mentioned more often than any other part of the YCW: California section. Seventeen interviewees (55%) talked about the wildlife in the exhibit, and a number of individuals mentioned more than one specimen. There were no obvious differences between the comments made by members of different ERB rating groups. Some people enjoyed certain organisms, such as the rattlesnakes, the sequoia tree, or the pika. For example, Thomas shared he liked the Academy's use of specific examples, because he felt visitors are more likely to care about what is happening to the planet if they can see exactly which species are at risk and why. Others talked about remembering the wildlife in a more general way.

Even though the plants and animals were clearly enjoyed by participants, it was difficult to determine what, if any, direct impacts they had on intentions or behaviors. Unlike other areas which offered specific suggestions for ERBs, the wildlife displays mainly described possible consequences of climate change. However, Naomi did say she liked the Plant a Tree, Help the Planet sign because it supported her side of a disagreement with her father about cooling their house using trees instead of air conditioning. She specifically stated

the sign gave her more “ammunition” against her father’s arguments. During the follow-up interview, Naomi said what she remembered best about the exhibit was that sign. In the weeks following her visit to the Academy, she had gotten her father to concede that planting trees was a better choice than getting an air conditioner.

Your Changing World: Earth

Twenty-two participants (71%) from all of the ERB rating groups talked about parts of the YCW: Earth section. The “Carbon in our Lives” and “Dreaming up Solutions” areas were mentioned most often. The objects most frequently discussed by interviewees were the carbon footprint balance, the inventions, the carbon graph, and the editorial cartoons.

Ten people brought up the carbon balance. Most of them were members of the high ERB group. As with the Carbon Café, study participants seemed to be more interested in this manipulative than general adult visitors were. There were a number of different complaints raised about the device. Almost everyone who discussed the balance pointed out that part of it was missing, which prevented users from getting a completely accurate result. On a positive note, this suggested people had actually attempted to use it. Some interviewees complained there were too many people in this area. Others were upset about children climbing on it or forcefully shifting it up and down. I could appreciate these comments, as I had also sometimes felt frustrated when observing visitors misusing the balance.

More than one person mentioned ideas from the carbon footprint balance when I asked if the exhibit offered any suggestions for environmental actions. However, interviewees rarely cited the balance directly as a motivation for changing their own behavior. Most participants who spoke about the balance already performed a high level of ERBs, so they may have already been familiar with its suggestions (e.g., fly less, bike more, or drive a smaller car).

In contrast, none of the eight people who talked about the inventions on display in the “Dreaming up Solutions” section were members of the high ERB group. Of the three inventions, the kinetic playground appeared to be slightly more popular than the solar oven or the hydrogen-fueled bicycle. Also, interviewees who initially liked the playground also tended to mention it again later. For example, Lauren brought up the playground in both interviews, as did Terry. Perhaps it was better remembered because it was unique. A playground which can function as an energy source, especially one conceived by a high school student, was a novel idea many visitors might not have heard before. Despite the attention the inventions received, visitor intentions or behaviors did not seem to be strongly influenced by them. In fact, a couple of participants specifically pointed out that these inventions were useful for people in other countries but not for Americans.

Seven participants representing all three ERB groups were struck by the strong visual of the giant carbon graph. Beginning in 1000 A.D., the line ran along the bottom of “Carbon in our Lives” at the level of most visitors’ shins. It suddenly began to rise just after 1750 A.D., passing eye level by 1950 and surging over 10 feet into the air by the year 2000. Carter called the graph “the most shocking image” of the exhibit, and “a powerful statement” of the impact of the Industrial Revolution on the atmosphere. Another interviewee said:

Benjamin: It's kinda hard to argue with... You look at that, 10,000 years there is nothing, and then in the last hundred years it goes up radically. It's hard to argue with that. That's pretty demonstrative.

Despite these and other comments about the graph being striking, it was never mentioned directly when talking about ERBs. Perhaps this is because, like the wildlife displays, the graph presented a climate change problem rather than a possible solution.

Five participants from all three ERB groups mentioned the editorial cartoons in the “Carbon in our Lives” section, and all five were frustrated by the use of humor in presenting a serious issue. For example, Rosalind thought: “it was strange to make a satire out of what will happen when we run out of our fuel and our food.” William voiced a similar opinion:

William: I think it might help to have a more real, a more urgent (message)... I think where that urgency comes out the greatest was in the cartoon part, and people are gonna go “oh, yeah, ha-ha-ha-ha” not realizing that hey, this is actually true, you know, this is actually what's gonna happen.

None of the people who mentioned the cartoons were entirely satisfied with them. In general, interviewees liked their messages but thought the issues raised by the cartoons should be presented in a more serious way. They were never discussed in connection with ERBs.

4.5.2 Exhibit Layout

The *Altered State: Climate Change in California* exhibit was attractive and eye-catching. As described in section 4.1, the exhibit appeared warm and inviting, likely due to the wood paneling and the color scheme. The layout and style were similar in many ways to some of the other exhibits in the building, such as *Islands of Evolution*. For the most part, the signs were easy to read and many of the accompanying pictures were stunning. There were a large number of images; one interviewee even complimented the Academy for providing “visual aids” with most of the text panels. Many others made positive comments about the exhibit’s layout and style, calling it nicely done, organized, and well designed.

However, during my observations I noticed several issues with the layout which could potentially have had a negative impact on a museum visitor’s experience. First of all, there were a limited number of hands-on activities. This might have made the exhibit less appealing to people who are not visual learners. One interviewee agreed:

Lilly: I'm kind of a kinesthetic learner. I like something in front of me to touch or do... and when I first walked from there [pointed to the museum cafeteria] I didn't really feel like there was anything that really caught my eye.

Manipulatives are valuable for engaging visitors who might not be drawn in by the visual displays of an exhibit. They are also popular with all learning styles, including visual learners.

Secondly, the number of signs in the exhibit was incredible. On my sixth day at the museum, I was still finding small signs I had not noticed before. Perhaps always being able to find something new was beneficial to regular visitors. However, I am not sure how it affected my study participants, most of whom were visiting the Academy for the first time. It is possible some first-time visitors could feel overwhelmed by the amount of information.

I was also concerned that the open layout might make the link between the three sections less obvious to people. Having a unifying theme is an important part of a successful exhibit. With so many places to enter and exit, *Altered State* might not have felt like a single interconnected area. I often had to point to the opposite ends of the exhibit at the beginning of each face-to-face interview before participants knew what part of the museum I wanted to talk about. One person confirmed my suspicion:

Sophie: And you know what? I didn't realize that it was all one thing. See, the way it's spaced out I didn't... I didn't realize that it was all kind of conveying the same message in just different, different ways.

Another consequence of the open layout was that museum visitors did not see the messages of the exhibit in any particular order. It is possible some would have had a different experience if they had gone through the exhibit in the opposite direction.

As with many museums, the Academy has a number of docents who generously volunteer their time to interact with visitors. Several times each day, docents would set up manned stations within the *Altered State* exhibit. However, I was surprised to observe that

these stations were not about climate change, but instead were typically about earthquakes, phosphorescing rocks, or sharks. If the docents were scheduled to be present, why not assign them to the exhibit itself? They could have answered questions about how to use the manipulatives properly or helped to guide museum visitors in how interpret the information being presented. Instead, these manned “mini-exhibits” about unrelated topics seemed to detract from the coherence of the exhibit. At least one of my interviewees mentioned that he was unable to enjoy YCW: California because of a talk about snakes going on in that area.

4.5.3 Summary of Findings about Design

In general, interviewees seemed to like the layout and design of the *Altered State* exhibit. Almost all of the participants made positive comments about the way information was presented. People called the design eye-catching, impressive, and beautiful. Some especially liked the interactivity of certain areas. A couple of interviewees mentioned they liked the elements which appealed to their own learning styles (e.g., visual, kinesthetic). However, there were some limitations of the exhibit’s design, such as its emphasis on visual stimuli, its open floor plan, and the presence of unrelated learning stations within the exhibit. These characteristics might have caused confusion or detracted from the experience for some people.

YCW: Earth was commented on by 26 people. Participants most often mentioned the balance, the Athabasca glacier images, the inventions, the cartoons, and the graph showing atmospheric carbon levels. In addition, 17 people were interested in the wildlife on display in YCW: California and 11 liked the Carbon Café, which was part of YCW: Home. Interviewees seemed to talk most about areas they found personally relevant. As Table 4 shows, there were only minor differences between the responses of the ERB rating groups.

Table 4. Comments about Design Elements

Participant	YCW: Home	YCW: CA	YCW: Earth			
	Carbon Café	Wildlife	Balance	Inventions	Graph	Cartoons
Low ERB Group						
Bridget		✓				
Cole		✓			✓	
Declan	✓	✓		✓		
Dylan	✓	✓				
Jacob		✓	✓			
Lilly	✓	✓		✓		
Richard					✓	
Terry	✓	✓	✓	✓		✓
Travis			✓		✓	
Zoey	✓	✓				
5 people 8 people 7 people; 10 comments						
Medium ERB Group						
Amber		✓		✓		
Andrew		✓		✓		
Carter		✓		✓	✓	
Diane						
Eleanor	✓			✓		
Jasper						
Kylie			✓			
Lauren		✓		✓		
Naomi		✓				
Nathan						
Rosalind	✓					✓
2 people 5 people 7 people; 8 comments						
High ERB Group						
Alexander			✓			
Ashley		✓	✓			
Benjamin					✓	
Cherie						
Gavin	✓		✓			
Ryan	✓		✓		✓	✓
Sophie	✓	✓	✓			
Thomas	✓	✓				
Vivian			✓			✓
William		✓			✓	✓
4 people 4 people 8 people; 12 comments						

Participants' existing levels of environmental responsibility did not appear to be strongly linked to the sections of the exhibit they recalled. The number of comments about each section was similar across all three groups. There were no particular trends in the low ERB group in terms of comments about YCW: Earth, but the medium group tended to talk most often about the inventions and the high group remembered the carbon balance best.

Design elements did appear to have a general impact on participants. The parts of the exhibit which offered specific suggestions about ERBs were recalled more often than other areas. The engaging, surprising, and fun elements of the exhibit also seemed to be the most memorable. The two manipulatives, the animals, and the powerful visual of the carbon graph clearly drew in the interviewees and captured their attention, making it more likely they would take home the messages of those areas.

Overall, only a few comments about specific areas of the exhibit aligned directly with participants' statements about intentions or actions. A small number of people said the Carbon Café influenced their intentions regarding food choices. However, design elements were discussed more often in conjunction with intentions rather than actual behaviors, and most areas of the *Altered State* exhibit did not seem to directly influence interviewees' behavior.

4.6 Exhibit Messages

Participants recognized there was much to learn from *Altered State*. Half said they found the exhibit educational or informative. Diane described the contents as “good, basic information for the general public.” Cole called it a must-see experience, especially for children. William liked how the exhibit put concepts into easy-to-understand terms for people who might otherwise only be exposed to climate change issues by the media. Some shared that they appreciated the Academy's effort to focus on science education rather than politics:

Kylie: I feel like sometimes when people do climate change they really cater to this, like, trying to prove something, whereas this one is just presenting facts, and I like that ... rather than trying to convince people who don't believe it, just giving the facts so that you're not actually arguing against something... it's more science-based rather than politics-based, and I appreciated that.

The messages in the exhibit did cause negative emotions for a few participants. For example, Ashley called the messages in the Extinction area “really frightening.” Similarly, after seeing the projections for global temperatures in the coming years, Travis shared:

Travis: ...how much its projected to rise over the next 10 to 20, 30, 40 years, I mean, that's frightening, and especially when you're 32 years old, you think, “I might be around in 40 or 50 years...”

Others said parts of the exhibit made them feel sad, depressed, frightened, or worried.

4.6.1 Main Messages

Section 4.1.4 outlined the main messages I perceived to be part of *Altered State*. Specifically: 1) climate change will have significant impacts on people, plants, and animals, 2) climate change is impacted by our choices, especially our transportation and food choices, 3) there are many ways to combat climate change, and 4) climate change is the direct result of human activity. As a starting place, I looked for evidence in the interview transcripts that participants had also garnered these ideas.

However, I did not anticipate their experience would align exactly with my own. Everyone internalizes information differently because of prior knowledge and existing beliefs. My thoughts about museum learning, science background, and position on climate change certainly impacted my impressions of the exhibit. I also spent over 80 hours reviewing the exhibit's contents. What I took away from the exhibit was likely very different from the messages perceived by a person who spent 15 or 20 minutes there.

All of the data analysis in this study involved interpreting interview data. However, this question required an additional level of interpretation. Only some of the ideas people took from the exhibit were explicitly stated; the rest were implied. My own understanding of the exhibit's messages surely influenced how I conducted this deeper level of analysis. I made every effort to understand what participants were trying to communicate to me and to report those ideas as accurately as I could, but it is possible I misinterpreted someone's comments about what they took away from the *Altered State* exhibit. The following sections contain my best effort to understand and share the ideas and messages interviewees took from the exhibit.

Impacts of Climate Change

There were similarities between my interpretation of the exhibit's first message and some participants' comments. Seven people (23%) talked about the impacts of climate change on living things. Some mentioned climate change having a negative effect on the environment or the planet in general. Others were more specific about climate change's impact on living things. For example, Dylan said the exhibit connected climate change events to previous mass extinctions. Andrew praised the exhibit for its focus on the impact of climate change on wildlife; as he pointed out, "there's more than us humans living on this Earth."

Seventeen participants mentioned the wildlife displays (see section 4.5.1), but only three specifically identified the climate's impact on animals as a message of the exhibit. Perhaps people thought it was too obvious to mention. It is also possible some participants enjoyed looking at the animals but missed the connection. One interviewee shared:

Ashley: I didn't spend enough time to understand why there was the glass case with the large animals, the bear, and the bobcat- or the mountain lion, and the condor... I mean, it's important to see those animals, I just didn't... I just wasn't sure why it was there...

When I explained to her the “Extinction” area was attempting to show a connection between mass extinction and climate change events, she said:

Ashley: Yeah, that was frightening... half of life on Earth is poised for... that was really frightening.

Ashley had clearly read the sign next to the glass case which attributes the current mass extinction partly to climate change and human activities. It contains the statement: “If we don’t change our actions, we could condemn half of all species of life on Earth today to extinction in a hundred years.” Interestingly, even though she read this sign and saw the preserved specimens of endangered and extinct animals, she did not seem to make the connection between them.

Of the seven people who saw the potential impacts of climate change on living things, only two specifically talked about humans. Cherie was one of them:

Cherie: I think it's just trying to give people information about climate change, and the kinds of things that are happening because of it, and what to potentially expect in the future. And what it means to people... it doesn't just affect animals that depend on a certain plant to flower at a certain time because of the migration... it affects people as well.

Again, it is possible participants knew this message already, or thought it was so obvious it didn’t need to be pointed out during the interview. Alternatively, they may have gotten the impression that climate change will affect other living things more than it will affect people, as there was significantly more information in the exhibit about the impacts on wildlife.

Our Choices Matter

The second idea I took from the exhibit was that human actions impact climate change. This message was mentioned by 14 participants (45%). However, most did not talk about specific impacts to the climate. Instead, they spoke more generally about the impact of

human activities on the environment, atmospheric carbon, or wildlife. For example, when I asked Declan for the primary message of the exhibit, he replied, “mainly the importance of our impact on the environment.” Based on other comments they made, it was clear these 14 participants did understand that the climate could be impacted by their choices.

Participants also seemed to notice the museum’s focus on the impact of daily choices, especially transportation choices. Half of the interviewees who talked about human actions remembered certain types of travel as having a more significant impact on the environment. This further supported my finding that the YCW: Earth section, especially the “Carbon in our Lives” area, may have had the greatest influence on participants.

Conversely, only two people specifically mentioned how food choices impact the climate. Both were members of the low ERB group. As reported in section 4.5.1, the Carbon Café did seem to be popular with some of the interviewees, but perhaps the messages of the manipulative were not as well remembered as the activity of “playing” with the plates of food. Or perhaps the messages about travel were remembered better because they contained information participants did not previously know. Several interviewees shared their surprise at learning how much worse jet travel is for the environment than driving a car.

Taking Action

The message most frequently mentioned by interviewees was the third: there are a number of ways to combat climate change. Nineteen people (61%) talked about this message. Some spoke more generally about there being “ways” to save the environment or to reduce their carbon footprint. Others offered specific examples of actions they could take to mitigate climate change, such as taking alternate forms of transportation, reducing what they buy, changing what they eat, or becoming more involved in community service efforts.

I considered this a separate message from “Our Choices Matter” because there is a difference between knowing we have an impact and knowing how to change. A few people did mention the exhibit’s ideas for trying to change attitudes and actions at a community, business, or government level. However, most participants talked about message related to reducing their own personal footprints through lifestyle changes. In other words, interviewees seemed to focus primarily on the messages about taking action in their own lives.

Something I did not immediately notice, but many interviewees did, was that most of the actions the exhibit promoted were not complex, expensive, or time-consuming. A number of other participants echoed the message: “there are many simple ways to combat climate change.” Kylie explained why this focus on small changes was so important:

Kylie: I also think a lot of the reason people have a hard time with global warming is because they think it’s so big that they can’t have an effect, so... the focusing on individual actions, I thought that was really important. It makes it a little bit more manageable, right, instead of just, “this is global warming, and you have to completely overhaul the system”, it’s, “this is global warming, and yeah, it’s huge, and important, but look at these things that you can do, just to make changes.” That was great.

Others praised the exhibit for its focus on making small changes. For example, Zoey said Altered State showed her how small changes in her day-to-day habits could have a big effect.

Human Causes of Climate Change

Only four participants (13%) voiced the fourth message: “climate change is the direct result of human activity.” For example, William shared:

William: I think that's what they're trying to do here is to get people to realize that, hey, you know, there's not a question about this, the way it's presented. This is actually happening, and we're a big part of why.

Others talked about how the exhibit illustrated the influence of recent human history on the environment. For example, three different participants said the rapid increase in the

atmospheric carbon graph was evidence of a human impact on the climate. However, this message was brought up by the fewest number of people. Most interviewees did not mention the climate specifically when talking about the impact of human actions, but said more generally that human activity has influenced the environment.

It is possible some participants avoided references to this message because it made them feel uncomfortable or they did not agree with it. Or perhaps people were simply using the terms environment and climate interchangeably. However, the only two areas which strongly promoted this idea were “Global Impacts” and the editorial cartoons. Global Impacts was often passed over by the general public and rarely mentioned by interviewees. The cartoons may not have been taken seriously.

Most of the *Altered State* exhibit was focused on climate change solutions, rather than the underlying causes of climate change. Thomas probably explained this best:

Thomas: ...the focus isn't really so much on who is to blame, it's happening... it's not a question of if it's happening, it's what are we going to do about it? Whether we're entirely to blame, or it's part us and part, just the world evolving... well, who cares? What are we going to do to stop it from getting to a point where it's really, really bad?

Of the four messages, this one seemed to be given the least amount of importance in the exhibit, and so perhaps it is not surprising that it was mentioned least often by participants.

Evidence for Climate Change

In addition to finding support for the four messages I perceived as being part of the exhibit, the interview transcripts revealed a fifth message I had not realized was there. Five people (16%) said the exhibit was trying to pass on the message that climate change is real and it's already happening. It is possible I did not notice this message myself because I already thought of climate change as a scientific fact before my visit.

The exhibit presented climate change as a real phenomenon without addressing any controversy. *Altered State* showed the current understandings of the scientific community without providing multiple perspectives or alternate theories. The quotes by Thomas and William in the previous section illustrated this nicely. Both men talked about how the exhibit presents the existence of climate change in a non-questionable way.

Not all participants entered the museum with the perspective that climate change is a fact. Jacob seemed surprised (and perhaps swayed) by some of the evidence presented:

Jacob: Well, the concept of global warming has been a little bit difficult for me. When I look at the glaciers... {slowly} that is pretty convincing... I had been to the Athabasca glacier and I remember it longer than that last picture [points]. And I was there in the 70s, no, 87, so, that's a long time ago, isn't it?

Seeing the glacier in person probably made the images, and the message that the Earth is warming, even more difficult to dismiss. Others talked about becoming convinced something must be happening to the Earth's climate after seeing certain parts of the exhibit, such as the glaciers or the carbon graph. Even participants who were already concerned about climate change said the exhibit strengthened their belief in the urgency surrounding the issue.

4.6.2 Reinforcement of Messages

Altered State is not an isolated exhibit; it exists within the larger context of the museum. According to Falk and Dierking (2000), the relationship between any exhibit and its larger physical context is an important part of its influence on visitor learning. The Academy supported the messages of the exhibit in a number of different ways, and the messages may have been more effective because of this reinforcement.

One participant commented that the Academy practices what it preaches. In the *Building Green* exhibit, museum visitors could see exactly how the museum is living its own

messages. Some participants spent a lot of time looking at this exhibit. Thomas and Cherie spent more time there than any other interviewees. Later, they shared with me that someday they hoped to follow in the Academy's footsteps and build a LEED-certified home.

Similarly, a number of participants found the messages of *Altered State* echoed by another adjacent exhibit, *Rainforests of the World*. In his follow-up interview, Benjamin recalled the rainforest and how he connected it to messages about climate change:

Benjamin: After we went to the exhibit, we went to the aquarium, the jungle... what do you call it... the rain forest. That sticks in my mind a lot too, and I know there's a big connection between people burning, taking back the jungle land and creating a different kind of agriculture and that sort of is affecting the world, because trees absorb carbon dioxide.

Carter also talked about remembering the issue of deforestation in *Rainforests of the World*. It is likely that seeing the rainforest exhibit either just before or just after visiting the *Altered State* exhibit helped to reinforce the messages of both areas.

Even non-exhibit areas of the museum reinforced the message of taking action for the environment. Several participants pointed out the Academy's trash bins during their post-visit interviews. One Californian said (approvingly) it was the first time he had ever seen a compost bin in a public building. Another liked the color images on each bin which showed people how to correctly separate trash, compost, and recyclable materials. Similarly, a third interviewee remembered the sign on the drinking fountains encouraging visitors to fill their own bottles. He said he already knew city water is as safe as bottled water, but really appreciated seeing the message on display at the museum. Although it was not mentioned by any participants, the museum's cafeteria also reinforced the importance of making food choices that protect the environment by only offering local, sustainably-produced foods.

The exhibit's messages were not only supported by the museum, but also by the city of San Francisco. Travis, who was visiting from New Jersey, said most San Francisco residents understand what a serious a problem climate change is even if most of the country does not. Similarly, Lilly shared, "I feel like the east coast is much less about conservation." Benjamin called San Francisco more forward-thinking than other parts of the country in terms of environmental actions. Many talked specifically about the city's support for ERBs, such as composting, recycling, and taking public transportation.

When I asked Zoey if she thought she was environmentally responsible, she responded it was practically a requirement for living in San Francisco. She also said the exhibit showed her father, who was visiting from out of state, the "green" culture of her city:

Zoey: I feel that it's just more a representation of where I live, so I guess for... my dad who I was there with, he doesn't see that as often, so it was more just like, it was an exhibit, at the same time it was kind of like, me being able to show him, "yeah, this is where I'm living, this is what we do here."

Others thought the exhibit would be more successful simply because it was located in such an environmentally responsible place. Several wondered if the exhibit would have the same impact if it was on display in another part of the country.

4.6.3 Influence on Behavior

The discussion of how *Altered State's* messages may have influenced behavior actually began in section 4.5, as the design elements and messages of an exhibit are closely linked. Design played an important role in sparking visitor interest and capturing attention. However, with the possible exception of one of the manipulatives, participants' intentions and behaviors did not appear to be directly impacted by the specific design of the exhibit. Instead,

Altered State's best design elements seemed to indirectly influence intentions and actions by delivering messages more effectively and helping people to remember them better.

It was difficult to find direct connections between certain messages and participants' intended or actual behaviors. Whether or not a participant intended to change or actually performed a new behavior did not seem to be directly linked to her recall of any particular messages. However, the two most commonly remembered messages, *Our Choices Matter* and *Taking Action*, did seem to align with new intentions and ERBs when the study group was considered as a whole. Specifically, individuals who talked about change or actually made changes most often focused on making new food or transportation choices.

Altered State's messages may have also directly influenced intentions or actions by positively reinforcing visitors' current ERBs. Some participants said the exhibit's messages showed them how their actions were related to climate change:

Ashley: ...I may know that it's a good thing to recycle, or to buy a hybrid vehicle, or to walk wherever possible, but to see it in that bigger context of all of the effects of climate change, just makes it seem that much more important.

When I asked Nathan what impact he thought the messages might have on his actions or the actions of others, he replied:

Nathan: I think in most cases people have already made up their mind, and if they're coming here then chances are they're more interested in environmental issues, and this is just kind of... it's educating them a little bit more, giving them a little bit more substance for their beliefs, but I think in most cases it's probably not changing too many people's minds. For me it doesn't really change anything.

Although Nathan and Ashley's comments seem to be in opposition, they were actually saying something very similar about how the exhibit might influence behavior. Both felt the exhibit's main function was to reinforce visitors' existing ideas, to give them "a bit more substance" for

beliefs they already held. Through this positive reinforcement, the messages of the exhibit may actually have been able to influence participants' intentions or future behaviors.

Some people made explicit comments about the exhibit's direct reinforcement of the environmentally responsible actions they were already taking. For example:

Lauren: ...kind of a reminder, and a little bit maybe more awareness, to bring it back to the forefront, because after while it just becomes routine on things and it seems like it's nice to go back and bring that to the forefront and go, "oh yeah, there's reasons why we do we do what we do."

Andrew and Jasper made similar statements. Some participants specifically identified parts of the exhibit which provided positive reinforcement. Alexander said the carbon balance made him feel proud of the decisions he was already making about alternate forms of transportation.

4.6.4 Summary of Findings about Messages

In general, participants found the exhibit to be informative and educational, and felt its messages had value to both children and adults. Several appreciated its focus on the science behind climate change instead of the politics or the controversy which can sometimes surround the topic. A few people said they experienced negative emotions related to the messages of the exhibit, such as sadness or fear.

As shown in Table 5, most people could state at least two messages they thought the exhibit was attempting to convey about climate change. The messages identified by interviewees were almost the same as those I had found during my initial data analysis. Current level of ERBs did not appear to make any difference as far as what messages were mentioned. Comments about the messages came from the three ERB rating groups with approximately equal frequency, with one minor exception; the idea that climate change has an impact on living organisms was said slightly more often by members of the low ERB group.

Table 5. Comments about Messages

Participant	Exhibit Messages				
	Impacts of CC	Our Choices Matter	Taking Action	Human Causes	Evidence for CC
Low ERB Group					
Bridget Cole					
Declan		✓	✓		
Dylan	✓	✓			
Jacob		✓			✓
Lilly			✓		
Richard	✓	✓	✓		
Terry	✓	✓	✓	✓	
Travis	✓				
Zoey			✓		
8 people; 16 comments					
Medium ERB Group					
Amber				✓	✓
Andrew		✓	✓		
Carter			✓		✓
Diane					
Eleanor	✓		✓		
Jasper			✓		
Kylie		✓	✓		
Lauren		✓	✓		
Naomi			✓		
Nathan					
Rosalind			✓		
9 people; 15 comments					
High ERB Group					
Alexander		✓			
Ashley	✓	✓	✓		
Benjamin		✓	✓	✓	
Cherie	✓				
Gavin			✓		
Ryan		✓	✓		✓
Sophie		✓	✓		
Thomas			✓		
Vivian					
William		✓		✓	✓
9 people; 18 comments					

Seven people said the exhibit showed the effects of climate change on living things, 14 talked about the impact of our choices on the environment, and 19 stated the exhibit offered simple actions which have a positive influence on the climate. Four people felt the exhibit identified human actions as a major cause of climate change. Additionally, five participants thought the exhibit offered convincing evidence of climate change. Interviewees were most likely to discuss the messages from the most popular parts of the exhibit, suggesting again that exhibit design played a role in which messages they remembered. They were also more likely to talk about messages if they were repeated in many places throughout the exhibit.

A number of exhibit messages were reinforced by the nearby areas of the museum. One participant described the entire Academy, including the climate change exhibit, as unified by a message of conservation. Even non-exhibit areas such as water fountains, trash receptacles, and the cafeteria echoed the messages in the exhibit. For some, the culture of environmental responsibility in San Francisco further supported the exhibit's messages.

Individual participants' intentions or behaviors did not seem to be directly associated with their recall of certain messages, but as a group they tended to align with messages about taking action and the impacts of food and transportation choices. The messages remembered did not appear to be linked to their ERB rating. Interviewees tended to discuss messages that were personally relevant; specifically, the messages of the exhibit appeared to positively reinforce existing environmental knowledge and behaviors in a number of participants.

4.7 Study Limitations

The face-to-face interviews had an impact on how some participants interpreted the exhibits' messages. For example, one couple decided to re-enter to the exhibit after we spoke to confirm some things they had said during the interview and to try out the carbon footprint

balance (they had skipped it initially). After their second pass through the exhibit, this couple came back and asked me to walk through the exhibit with them. Clearly, the interview was significant to their experience.

Other participants were influenced by the interview process in more subtle ways. As I talked about in section 4.6.1, Ashley did not link the animal displays to the messages about climate change until I explained the connection during our interview. Similarly, if I had not interviewed Jacob he might not have spent as much time thinking about the impact of his commute on the environment (see section 4.3.1). My follow-up phone call to Jacob probably reinforced this message even further. If he does eventually make changes in the future, it would be impossible to separate the impact of his visit to the Academy from the influence of the interviews.

When I re-interviewed participants, many recalled the same areas and messages they talked about in their initial post-visit interview. They might have remembered these areas either way, but it is possible talking about them during the first interview cemented those memories more firmly in their minds. In fact, during the second interview some people may have actually been recalling the act of telling me about those parts of the exhibit.

Performing this case study, especially the interviews, changed the experiences of participants. People might have answered the questions differently if data were collected in another way (such as a take-home survey). The conversations would also have been different if the interviews had been conducted by a different researcher. It is even possible people would have answered differently if they had never been interviewed at all. There is no way to prevent interviews from influencing participants' experiences; it is simply a characteristic of this type of research.

The potential also existed for the interview process to negatively impact my results. Participants might have said things simply because they thought I wanted to hear them. They might have tried harder to remember the exhibit or change their behavior after visiting the museum because they knew I was going to interview them again. I attempted to address these concerns as best I could.

When I described the study to potential interviewees, I explained I was evaluating the museum, not its visitors. I reassured them my questions had no right or wrong answers. Questions about current ERBs were asked conversationally so as not to make participants feel like they were on the spot. I also tried to ask about their intentions regarding future actions in such a way that suggested I had no expectations about their answers. This careful wording sometimes resulted in vague responses, but it was more important to me that interviewees did not feel pressured to exaggerate their intentions or behaviors in an effort to deliver more “socially acceptable” answers. I felt these efforts resulted in more frank, honest responses from participants.

In addition to the issues found in all interview-based research, there were also limitations specific to this study and this museum. For example, I had originally wanted to make detailed observations of each interviewee interacting with the exhibit’s contents and to record exact times using a stopwatch. Unfortunately, the floor plan made this nearly impossible. In order to record start times I had to stand just outside the exhibit on the main floor of the museum, but to observe the behaviors of potential interviewees I had to move inside the exhibit. As I didn’t know ahead of time who I would later be interviewing, I found myself sometimes trying to keep track of 5 or 6 groups of adults at one time without being

able to see them all from a single location. As a result, I was only able to record generally what groups did during their visit and time only as a total number of minutes.

My observation notes improved as I learned the most common paths through the exhibit and the characteristics to look for in highly engaged visitors, but I was never able to get the level of detail I had originally hoped for. This situation could have been improved with additional researchers, although it was not an option for this study. Also, an exhibit with fewer possible entrances and exits might have been less challenging. Another solution might be to identify study participants prior to their entry into the exhibit. Although the criteria for inclusion in this study would not have allowed such identification, in future studies of this type it might be valuable to pre-select candidates to reduce the number of people being observed at one time.

During my observations I also had to “follow” potential interviewees through the exhibit, which might have made some people feel uncomfortable, behave differently, or even leave the exhibit prematurely. I made every effort to be discreet. I tried to appear that I was more interested in the exhibit than the visitors, most often by reading signs and pretending to take notes about the content while I was actually recording behavior. However, some people may have realized I was watching them. Again, having additional observers or a different floor plan may have improved this aspect of the study.

Surprisingly, my manner of dress might also have been a limitation. I chose to dress in business attire, which is significantly more formal than the typical museum visitor. In addition the Academy asked me to wear a museum-issued badge each day. As a result, I was often approached as though I was a museum employee. Even though I tried to establish that I was not affiliated with the Academy at the outset of each interview, some participants might still

have thought of me as a museum insider. This impression could have tempered people's negative comments about the exhibit. On the other hand, dressing more casually might have made people suspicious of my behavior; most museum visitors do not stay in one exhibit for many hours at a time. Visitors might also have been less open to my request for an interview had I looked less professional. I do not believe I would dress differently in the future.

Finally, as in any qualitative study, I chose to sacrifice breadth to gain depth. I spoke to a very small number of people who were chosen with a set of criteria which probably eliminated close to 95% of Academy visitors from consideration. The trends I reported in this chapter were seen in this select group of highly engaged museum goers. As a result, this study does not necessarily reveal the experiences of general public visitors. However, I strongly believe these findings have significant value both to museum education and environmental education, as they offer insight into the most successful aspects of the exhibit.

5. SUMMARY AND IMPLICATIONS

This chapter begins with a summary of the major findings of this exploratory case study. Next it connects the study to the theoretical models of behavior change outlined in the literature review. Suggestions for the improvement of future exhibits related to environmental action are offered, developed from a combination of this work and larger theoretical perspectives. I conclude with some possibilities for future research in the areas of informal environmental education and the promotion of environmentally responsible behaviors.

5.1 Summary of Research Findings

The central research question driving this case study was: How does the *Altered State: Climate Change in California* exhibit influence the intended and actual ERBs of adult visitors to the California Academy of Sciences? Figure 1 presents a visual answer to this question.

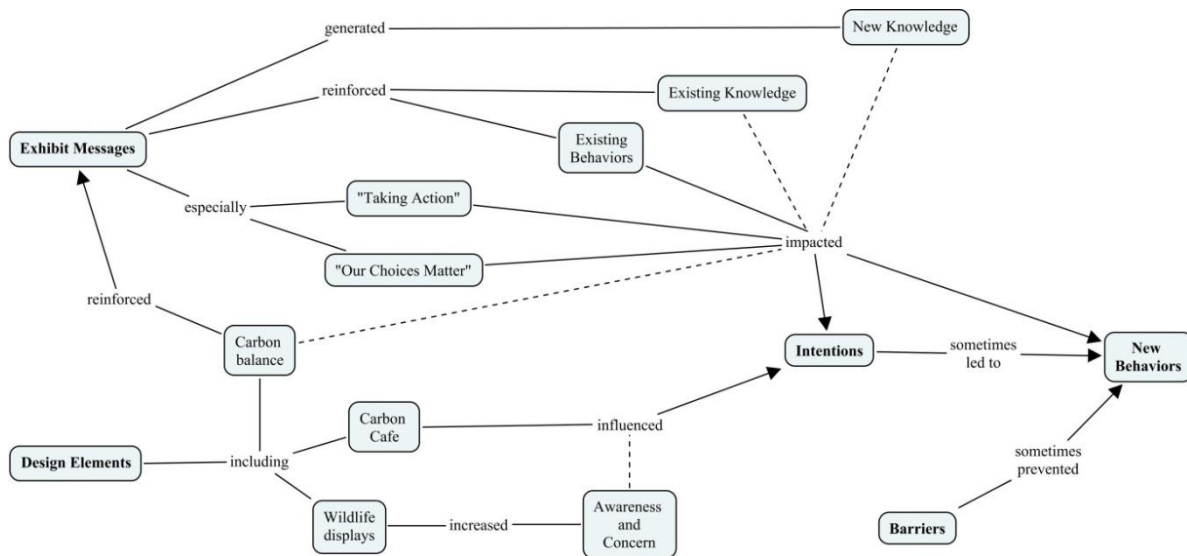


Figure 1. Visual Representation of the Impact of *Altered State* on Intentions and Behaviors

Figure 1 shows the links between elements of *Altered State* and participants' intended and actual environmentally responsible behaviors. Direct links are represented by solid lines and indirect links are shown using dotted lines. As the diagram illustrates, this study found two of the exhibit's messages may have directly influenced intentions and ERBs. Further, the exhibit messages appeared to reinforce existing behaviors, which may have had direct effects on intentions and future actions. In addition, the exhibit messages generated new knowledge or reinforced existing knowledge in a number of participants, which may have indirectly impacted their intentions or behaviors.

The design elements of the exhibit, with the exception of the Carbon Café, had very little direct effect on intentions or actions. Some elements seemed to increase awareness or concern (e.g., wildlife displays) which may have had indirect effects. The carbon footprint balance seemed to reinforce the exhibit's messages about transportation choices and taking action. In this way, it may have affected some participants' intentions or behaviors.

As shown in the visual representation, one of the significant findings from this study was the lack of a connection between the *Altered State* exhibit and potential barriers to behavior change. Although participants frequently talked about barriers, they did not mention any aspects of the exhibit which addressed those barriers. Further, my own analysis of the exhibit contents found very little regarding behavior change barriers visitors may encounter. I discuss this further in section 5.3 as part of my suggestions for future exhibits.

Sub-question 1

What are visitors' intentions regarding their performance of environmentally responsible behaviors immediately after experiencing this exhibit? During the face-to-face interviews, about a third of the participants talked about their future actions. Some of

these individuals said they wanted to make general changes, but more than half named specific ERBs they wanted to do differently as a result of experiencing the *Altered State* exhibit. The most common response was making different food choices. Others mentioned reducing their driving, planting trees, or using re-usable containers.

There seemed to be a connection between environmental responsibility and the intention to perform more ERBs in the future. About half of the people in the low ERB group intended to change their behavior in some way, as did about half of the members of the medium ERB group. In contrast, less than a third of the high ERB group talked about change.

Members of the low ERB group tended to discuss change more generally, often saying the exhibit would make them “think more” about environmentally responsible actions. People in the medium ERB group were more likely to name specific new actions they wanted to try. The few people in the high ERB group who talked about change tended to discuss refining their existing ERBs. In all three groups, there were also participants who said they intended to continue doing the environmentally responsible actions they were doing prior to their visit.

Sub-question 2

How do these intentions compare to actual self-reported behaviors several weeks later? All of the people I followed up with were continuing to perform the original ERBs they had identified in their post-visit interviews. In addition, several participants reported actual changes in their behaviors following their visit. Changes included new driving or carpooling habits, buying more local food, new recycling habits, switching to using reusable water bottles, or consistently washing clothes in cold water. More changes fell into Category 4, Alternate Transportation Choices (see section 4.2.4) than into any other category. A couple of changes were unexpected. One person had not shared any intention to change during the first

interview, yet started performing two new ERBs. Another who had intended to make different food choices started carpooling more often instead.

Participants who reported actual changes were evenly distributed across the three ERB rating groups. However, differences were still evident between them. The two individuals who experienced unexpected changes were both in the low ERB group. The two people in the medium ERB group who made specific changes had previously identified (in the face-to-face interviews) exactly which new ERBs they intended to do. The two members of the high ERB group who changed did not incorporate any new ERBs into their lives, but instead refined their existing behaviors.

Sub-question 3

What reasons do visitors give for differences between their intentions and actual behaviors, if any? I anticipated some participants would not make the changes they had intended. I had hoped to ask them directly about the reasons for the difference between their intentions and behaviors. However, almost all of the people I spoke to who had intended to change actually did, or were still planning to in the future. In addition, I was unable to follow up with all of the participants who said they intended to change their future actions.

Still, I was able to collect a significant amount of data related to this question. Every interviewee talked about barriers to behavior change, regardless of whether or not they intended to make changes to their own ERBs. External barriers were brought up much more frequently than internal. Common external barriers were lack of money, job responsibilities, lack of time, cultural expectations (such as consumerism and convenience), lack of societal support, and lack of sustainable alternatives. Internal barriers included not wanting to change,

not knowing how to change, not feeling a need to change, and the belief that individual pro-environmental actions do not matter.

Participants from all three groups talked about external barriers. Members of the low ERB group averaged twice as many statements per person. Similar external barriers seemed to exist for all interviewees regardless of their level of environmental responsibility. However, it is possible lack of community support has more of an inhibiting effect on people in the low ERB group. Internal barriers were also only consistently mentioned by the low ERB group, suggesting they may be less of an issue for people in the other two groups.

One interesting exception was the belief, “I don’t need to change.” This was the only internal barrier not said by anyone in the low ERB group. At the same time, it was the only one discussed with any frequency by the medium ERB group, and the single internal barrier mentioned by members of the high ERB group. Perhaps the feeling of not needing to make changes arises partly as a result of being environmentally responsible. It is possible people reach a personal threshold where they feel they are already doing enough for the environment.

Sub-question 4

What components of the exhibit’s design seem to influence visitor intentions and/or behaviors? The design components most frequently mentioned by participants were the Carbon Café manipulative, the carbon footprint balance manipulative, and the wildlife displays. These areas seemed to be the most engaging and interesting to interviewees. Additionally, people tended to talk about the Athabasca glacier images, the inventions, the cartoons, and the graph of atmospheric carbon levels more often than other parts of the exhibit.

The Carbon Café may have had an influence on the intentions of some participants. Several people specifically referenced the Café when talking about making new food choices. Other comments about intentions could also be linked to certain design elements, such as Carter's interest in alternative fuels after viewing the inventions. Specific parts of the exhibit were less frequently mentioned in the follow-up interviews. Those who changed their behavior tended to talk about the messages of the exhibit rather than its design. For example, the most common actual change (new transportation choices) may have been the result of recalling messages about making small changes. However, the second most popular part of the exhibit, the carbon footprint balance, probably reinforced those messages for some people.

Participants' current level of ERBs seemed to have no connection to the parts of the exhibit they mentioned. I could not find any obvious trends in the responses given by members of the different ERB rating groups. Instead, the areas discussed by interviewees tended to those which they could relate to in some way. For example, some people said they were drawn to parts which aligned with their preferred learning style. Participants often paid the most attention to areas which reminded them of something important in their own lives.

Sub-question 5

What environmental messages do visitors appear to take from the exhibit, and how do they seem to influence visitor intentions and/or behaviors? Participants seemed to take several main messages from the exhibit. The most common idea was that there are simple actions we can take which have a positive impact on climate change. Mentioned with almost equal frequency was the related message that our choices, especially our food and transportation choices, affect the environment. Some interviewees recalled messages about climate change as a real phenomenon, climate change's effect on living things, and human

activity as responsible for climate change. Only a few participants remembered messages about societal efforts which can combat climate change, or messages about climate change having significant effects on humans.

As at individual level, specific intentions or behaviors could not be attributed to the recall of particular messages. For example, a person who recalled messages about the impact of travel was no more likely to make changes to his commute than a person who talked about climate change having an impact on animals and plants. Still, the most common intentions and actual changes (new food and transportation choices, respectively) across all participants did align with the two most commonly discussed messages (there are simple actions which have a positive impact on climate, food and transportation choices affect the climate). These messages seemed to have the most direct impact on intentions and behaviors.

There seemed to be no link between the messages remembered and a participant's existing level of ERBs. Instead, the messages people tended to recall were those they could personally relate to in some way, such as remembering a previous trip to a glacier or receiving positive reinforcement for current environmentally responsible actions. In fact, positive reinforcement for ERBs seemed to have a significant direct influence on some participants' intentions to continue performing certain actions or the actual continuation of those behaviors.

5.2 Connection to Theories

As discussed in section 2.7, Simmons (1991) found the majority of U.S. nature centers were interested in promoting environmentally responsible behavior but seemed to lack an understanding of how to achieve this goal using environmental education. In contrast, the contents and messages of the *Altered State* exhibit tended to align well with the seven categories for EE outlined by the NAAEE (see Appendix A). The exhibit presented a great

deal of ecological knowledge, knowledge of environmental issues, and to a lesser extent, socio-political knowledge. Some of the contents seemed to invoke an emotional response from visitors. A significant number of messages were meant to promote environmentally responsible behaviors. The exhibit also tried to address both locus of control and personal responsibility. The only category not well covered by *Altered State* was the development of relevant skills related to the performance of pro-environmental actions.

In addition to following EE guidelines, the exhibit also seemed to align with the ERB variable models explored in section 2.5.1. With the exception of environmental action skills, the exhibit addressed each of the affective and cognitive variables identified by Hines et al. (1986/1987) as well as each of the major variables outlined by Hungerford and Volk (1990) in the environmental citizenship behavior model. As these variables have been shown to increase environmental literacy and ERBs, it may be that the exhibit's alignment with these models resulted in the positive influence on intentions and behaviors seen in some of this study's participants.

Some aspects of *Altered State* also aligned with the human social behavior models in section 2.5.2. For example, all three personal values (biospheric, altruistic, and egoistic) in Stern's value-belief-norm theory were addressed by the exhibit's messages. Based on this study's findings, the strongest personal value it seemed to encourage was biospheric, or concern for the environment. The exhibit also appeared to address the relationship between humans and the environment, beliefs in the adverse consequences of climate change, and some participants' beliefs in their ability to reduce the threat of climate change. The exhibit's promotion of values and pro-environmental beliefs may have resulted in the positive changes in intentions and behaviors reported by some interviewees.

Certain aspects of Fishbein and Ajzen's (2010) reasoned action approach were supported by the exhibit. Messages about the environmental consequences of performing certain actions, such as flying, seemed to influence the attitudes of some interviewees about those behaviors. Further, the reinforcement of messages by other parts of the Academy and the pro-environmental culture of San Francisco may have positively impacted descriptive normative beliefs in a few participants. It is possible these aspects had an effect on the intentions or behaviors of some participants.

Altered State aligned with aspects of both environmental behavior models and human social behavior models. These two perspectives are not mutually exclusive, nor are they even theoretically at odds; they simply approach the idea of changing behavior from two different directions. It is not necessary for an exhibit or any other learning situation to align with only one type or the other; in fact, incorporating both might be more successful at modifying behavior than either type alone. As I explained in section 2.6, both types of models offer mechanisms for influencing ERBs which have met with success in different learning environments.

5.3 Suggestions for ISLEs

My goal in this case study was to “find the bright spots” (Heath & Heath, 2010) in the *Altered State: Climate Change in California* exhibit; in other words, the areas which seemed to be most successful at changing intentions and behaviors. Using the findings of this study in combination with existing theories of learning and behavior change, I have developed the following recommendations for future exhibits in informal science learning environments: promote active learning, provide facilitators, promote specific actions, address barriers, provide positive reinforcement, and suggest a path.

Promote Active Learning

The manipulatives were some of the most enjoyed and remembered parts of the *Altered State* exhibit. Manipulatives promote active learning, a concept frequently discussed in science education. Rather than passively receiving information through signs or video screens, visitors actively engage with manipulatives, typically by performing a series of steps to achieve a particular goal. Both of the manipulatives in this study, the carbon balance and the Carbon Café, added significant value to the exhibit. The balance may have ultimately been more successful at changing behavior as it required more active engagement from visitors.

As previously discussed, the Carbon Café seemed to have the greatest impact on the behavioral intentions of participants. However, the level of active learning at the Carbon Café was not very high; all people had to do was lift up the plates. The suggested activity, to calculate a day's worth of carbon impact, was probably not completed by most interviewees. As a result, the Carbon Café was remembered as an enjoyable activity but its messages were less frequently recalled.

The carbon balance was significantly more complicated. Visitors had to actively try to figure out what to do with the different weights while thinking about their current ERBs. Based on my observations of general visitors' interactions with the balance, I initially believed its complexity would have a negative impact. However, my results suggest the messages around the carbon footprint balance were better remembered by participants. In addition, it may have promoted actual behavior changes, as the most common new actions were related to transportation.

Perhaps the manipulatives (especially the balance) tended to be passed over by most general public visitors because they required a higher level of interaction and engagement.

Just as students sometimes experience frustration with active learning techniques in the classroom, visitors may be less inclined to take on the challenge of an active learning situation in a museum setting. Yet participants' intentions and behaviors seemed positively impacted when the manipulatives were part of their experience.

Discovering how to engage more visitors in active learning experiences should be a goal of every ISLE, especially when promoting behavior change. A further suggestion related to the manipulatives is the addition of facilitators who can provide visitors with direction and encouragement while using active learning devices. Educators can also help to prevent the mistreatment of manipulatives by showing people how to use them properly.

Provide Facilitators

According to Falk and Dierking (2000), virtually all meaningful learning is socially mediated. Even individuals who visit a museum alone will typically seek out ways to add a social dimension to the experience, such as telling someone else about their visit after the fact. In other words, the importance of the sociocultural context in ISLEs should not be underestimated. One of my observations about general adult visitors was their tendency to quietly observe the exhibit's contents; in contrast, highly engaged visitors tended to talk more while experiencing the exhibit. It is likely these social interactions facilitated the learning process and helped study participants to remember the exhibit's messages. Also, as I said in section 4.7, the act of being interviewed (i.e., talking to me) likely reinforced the messages or helped people to interpret them, possibly leading to an impact on behavior.

Knowledgeable facilitators can help people, especially those visiting by themselves, to have more socially meaningful experiences. The primary purpose of any educator is to act as a facilitator to the learning process (Novak, 1977). In addition to promoting the use of active

learning areas such as manipulatives, ISLE educators can encourage people to view areas of an exhibit they might not be drawn to on their own. My findings suggested participants tended to focus mainly on things they could personally relate to, which could potentially have had a negative effect on their exposure to new ideas. Further, in an exhibit on behavior change such as *Altered State*, educators can encourage visitors to talk about their thoughts regarding new behaviors. This might help people to work through some of their personal barriers to change. It could even influence social norms, as it might strengthen the normative belief that other people support pro-environmental behaviors.

Promote Specific Actions

Another way ISLEs can align their exhibits with theories about human social behavior models is by presenting clear options for ERBs. Fishbein and Ajzen (2010) asserted that identifying the behaviors to be addressed is an important component to affecting change. In this study, the best remembered message by participants was that individuals can impact the environment by making small changes to their everyday actions. Many could remember the exact behaviors encouraged by the exhibit, such as driving a hybrid or eating less meat. Promoting a few specific changes may have made the *Altered State* exhibit more successful than if it had suggested larger, more diffuse actions. Some have even argued that individuals who make small changes to their ERBs are more likely to make larger changes in the future, although more research is needed to confirm this belief (Ardoin, 2009).

In addition to promoting these actions, exhibits should try to provide visitors with personal reasons to change their current behavior. These reasons can positively impact attitudinal beliefs about pro-environmental behaviors. Social behavior theories have suggested that people are more likely to make changes if they believe a certain behavior has personal

value. For example, explaining how much money or time a certain ERB could save might be beneficial to influencing a person's future actions. According to the reasoned action approach, knowing a choice will have personal benefits is more likely to affect change than the knowledge that a behavior is generally better for the environment.

Address Barriers

Exhibits should specifically address the likely barriers to performing certain behaviors. This study found the perception of barriers seemed to be more directly linked to anticipated and actual performance of ERBs than any of the exhibit's contents or messages. Barriers are obstacles which can negatively impact a person's perceived level of control over the performance of a behavior (Ajzen, 2002). Although this study surveyed only a small group of highly engaged individuals, it is very likely that general public visitors experience many of the same barriers described by participants.

This study found external barriers such as lack of time, lack of money, and lack of community support were perceived by people at all levels of environmental responsibility. Exhibits which address these barriers, perhaps by providing direct suggestions about how to overcome them, may be more successful at effecting positive changes in behavior. Additionally, some individuals experienced internal, or mental, barriers to change. These barriers could potentially be overcome with the addition of opportunities for social interaction and dialog between ISLE educators and visitors.

Provide Positive Reinforcement

In addition to addressing the barriers which may prevent new behaviors, it is important to positively reinforce the ERBs already being performed by visitors. Many of this study's participants felt the Academy gave them with a significant amount of positive reinforcement,

and this seemed to impact their intention to continue being environmentally responsible. Falk and Dierking's (2000) contextual model highlighted the importance of prior knowledge and interests in museum learning. By reinforcing the actions a visitor is already taking, an exhibit connects with her existing knowledge and beliefs about environmental behavior. This may increase her interest in other areas of the exhibit. It might even strengthen her personal beliefs about the importance of ERBs and affect her future decisions about environmental actions. Thirdly, the reinforcement of behavior may positively impact a visitor's perceived behavioral control beliefs about new behaviors by reminding her that she has managed to overcome other barriers to behavior change in the past.

Suggest a Path

One way to meet the needs of a diverse audience of learners is to offer a number of possible paths through an exhibit (NRC, 1999), and *Altered State* does this well. However, the majority of Academy visitors, including this study's participants, entered the YCW: Earth section of the exhibit first. As a result, they encountered messages about what actions can be taken to combat climate change prior to being exposed to reasons why those actions should be taken. Simply traveling through the exhibit in the opposite direction may have had an impact on how they perceived the messages about environmentally responsible behaviors.

Future exhibits about taking action might potentially be more effective if designed with a suggested path of travel. Presenting messages in a particular order can provide learners with a knowledge framework to build upon as they move through an exhibit. One possibility is to begin with messages that many visitors can personally relate to or connect with their prior experiences. Another is to present a narrative with mental "stepping stones" to guide visitors from one idea to the next. An excellent example of this concept is illustrated by the

Academy's *Rainforests of the World* exhibit, which takes people on a journey through the levels of the rainforest. All visitors begin on the rainforest floor and end up in the canopy, a path which helps to "tell the story" of this unique ecosystem.

Offering a path can also help to clarify the central theme of an exhibit. Some interviewees did not seem to recognize the connection between the three sections of *Altered State*, which negatively impacted their ability to link the messages together. For example, many people recalled the animal displays from one section, but only a few connected those displays to concerns about climate change in the adjacent section. The open layout may have limited the ability of some participants to recognize a main theme, reducing the effectiveness of the exhibit's messages about taking action.

5.4 Future Research

Much work remains to be done on more effective ways to impact environmentally responsible behaviors in informal science learning environments. The suggestions presented in the previous section are grounded in existing theories, but are still primarily based on the findings of this case study. Further studies should be undertaken to expand our understanding of how exhibits may affect the intentions and behaviors of the general public.

A longitudinal study of this type could add significant value to these findings, as measurable behavior changes may take a significant amount of time to materialize following a free-choice learning experience (Ardoin, 2009). This study was limited by the relatively short span of time between the participants' initial visit to the Academy and their follow-up phone interviews. Also, related experiences are known to play a critical role in reinforcing and expanding what is learned in a museum setting (Adelman et al., 2000; Falk & Dierking, 2000). A longer study, perhaps one which follows up with participants over a period of a year,

could reveal long-term changes in behavior as well as the types of subsequent events which positively or negatively influence ERBs.

Another logical step in this line of research would be to expand the original study to include more visitors. More structured interview protocols could be developed using the knowledge gained from this work, allowing the responses of different individuals to be more easily compared. A team of researchers working together would also be able to collect more precise time measurements and behavior observations, as well as interview a much larger group of participants. The findings of a study of this type would potentially be more generalizable to the general public. They could also illuminate additional strategies for ISLEs which could not be discerned by the current study.

Another possibility for future research would be to repeat the current study using multiple exhibits at different sites around the country. A case study, although it provides a valuable in-depth look at a specific context, can be limited in its generalizability (Yin, 2009). Additional locations would increase the validity of the findings from this study, and would likely yield additional insights about the impact of ISLEs on pro-environmental behaviors not revealed by this work. Further, it is possible the somewhat controversial nature of climate change affected some of my participants' experiences. It may even have influenced their interpretation of the exhibit's messages. Studies of exhibits which do not include the topic of climate change could be valuable in understanding the role of controversy in this work.

This study was exploratory in nature, and made no predictive claims or tests. Further studies could be done to explore some of its findings using more experimental measures. For example, a person's current level of environmentally responsible behavior seemed to have a

significant connection to intentions, behaviors, and perceived barriers. This finding could perhaps be explored further by deliberately selecting participants based on an ERB rating.

Another possibility for experimentation would be to design an ISLE exhibit with the intention of influencing behavior. The *Altered State* exhibit was not fully representative of any one theoretical model of behavior change. Therefore, drawing any conclusions about the efficacy of those models would be inappropriate using the findings from this study. Future researchers might design an exhibit to align with one of the existing theories on behavior change. This study might then serve as a guideline for testing the effectiveness of that exhibit.

5.5 Concluding Remarks

What is environmental literacy? How can it be fostered in learners? What is the role of environmental education in this process? These questions have been at the heart of EE debates for many years, and their answers remain elusive. At the same time, there is no question about the importance of EE in the 21st century. As concerns continue to mount about global issues such as climate change, so does the need for quality EE for learners of all ages. Some formal programs have had measurable success at impacting environmentally responsible behaviors, but most non-formal programs and general public settings seem to be struggling. Are these learning environments truly failing to impact people?

I believe ISLEs can and do influence thoughts and actions related to environmental responsibility. A significant body of literature illustrates the great potential of these settings for meaning-making and learning. By exploring the experiences of highly engaged visitors, I hoped to understand which aspects of a single exhibit might be most successful at promoting environmental responsibility. More studies are needed to validate and expand these findings, but it is my hope that the insights gained here can be used to improve future ISLE exhibits.

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APPENDIX A

THE SEVEN CATEGORIES FOR ENVIRONMENTAL EDUCATION

These categories were included in the NAAEE Guidelines Project, as described by Volk & McBeth (1998), who adapted their descriptions from Simmons (1995):

Ecological Knowledge refers to the knowledge of major ecological concepts. Ecological knowledge also refers to a knowledge and understanding of how natural systems work, as well as a knowledge and understanding of how natural systems interface with social systems.

Socio-political Knowledge includes an understanding of the relationship between beliefs, political systems, and environmental values of various cultures. Socio-political knowledge also includes an understanding of how human cultural activities (e.g., religious, economic, political, social, and other) influence the environment from an ecological perspective. Also included within this category is knowledge related to citizen participation in issue resolution.

Knowledge of Environmental Issues includes an understanding of environmental problems and issues caused as a result of human interaction with the environment. Also included within this category is knowledge related to alternative solutions to issues.

Affect refers to factors within individuals that allow them to reflect on environmental problems/issues at the intrapersonal level and to act on them if they just the issue/problem warrants action.

Cognitive Skills are those abilities required to analyze, synthesize, and evaluate information about environmental problems/issues and to evaluate a select problem/issue on the basis of evidence and personal values. This category also includes those abilities necessary for selecting appropriate action strategies, and for creating, evaluating, and implementing an action plan.

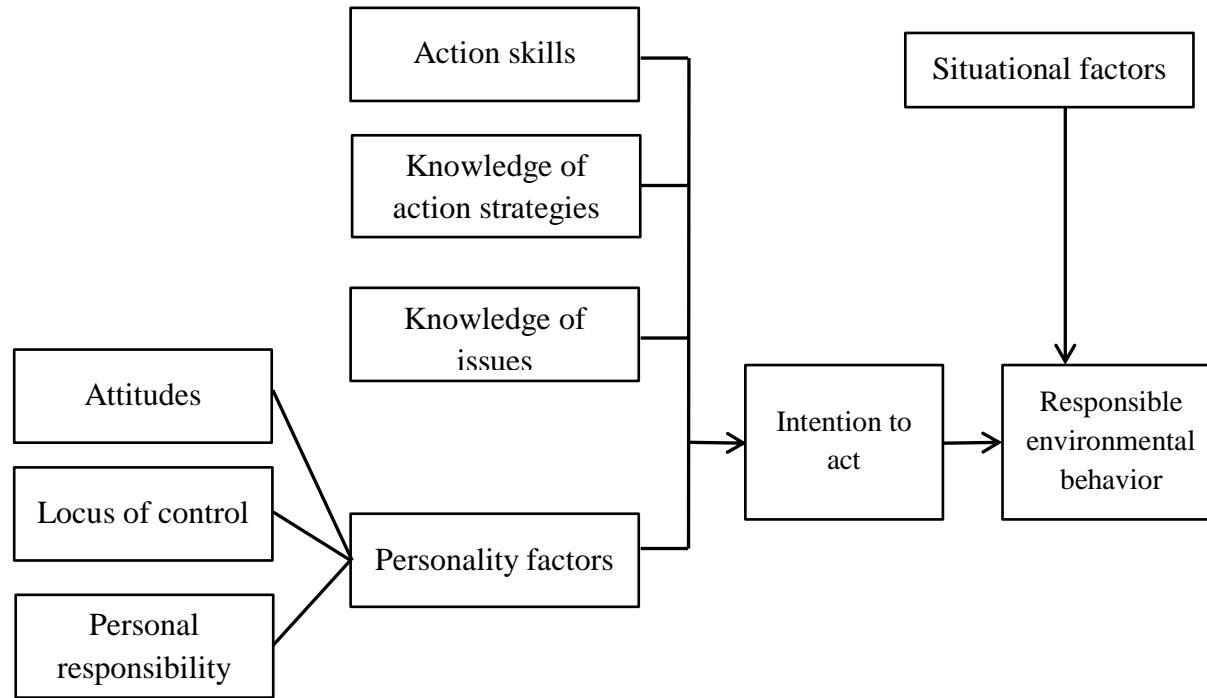
Environmentally Responsible Behaviors include active and considered participation aimed at solving problems and resolving issues. Categories of environmentally responsible actions are persuasion, consumer action, ecomanagement, political action, and legal action.

Additional Determinants of Environmentally Responsible Behavior include locus of control and the assumption of personal responsibility. (Volk & McBeth, 1998)

NOTE: While the terms “issue” and “problem” appear together in many of the NAAEE category descriptions, they do have different meanings. Hungerford & Volk (1990) explained the distinction as the difference between a situation where something is at risk (a “problem”) and a situation where beliefs and values differ about how to address that risk (an “issue”).

APPENDIX B

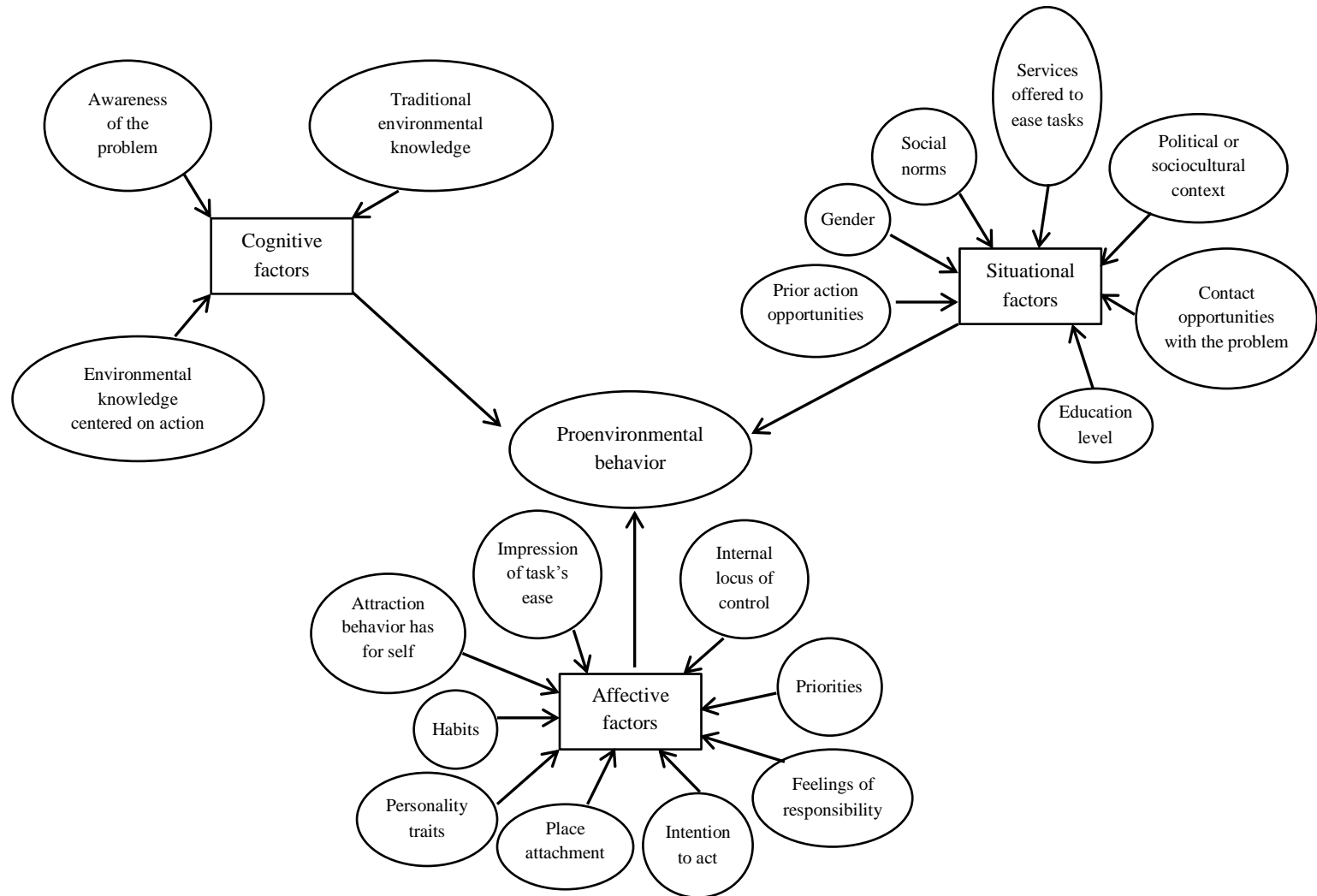
THE HINES MODELS OF RESPONSIBLE ENVIRONMENTAL BEHAVIOR



From Hines, Hungerford, & Tomera (1986/1987), page 5.

APPENDIX C

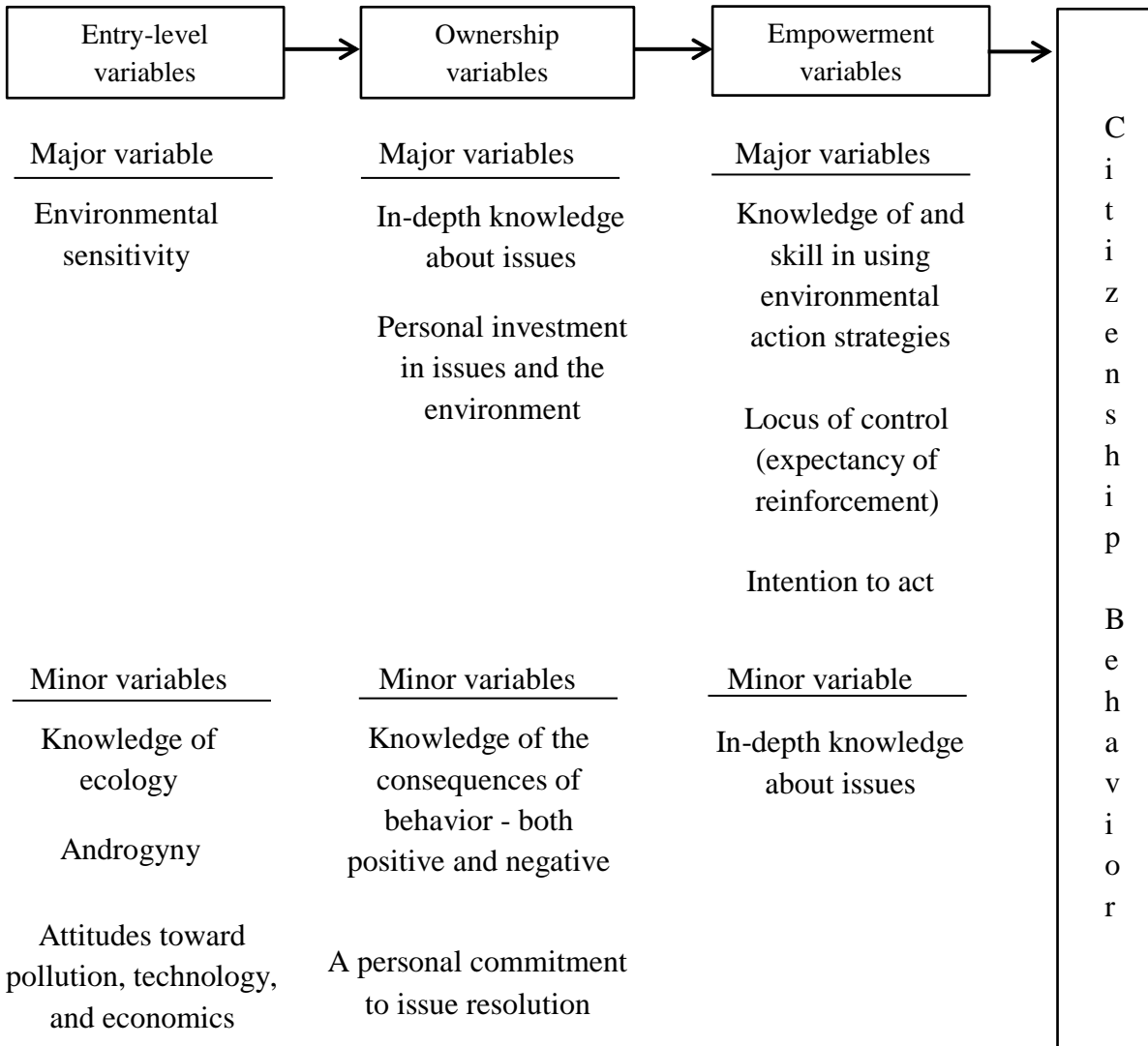
FACTORS INFLUENCING PRO-ENVIRONMENTAL BEHAVIOR



From Pruneau et al. (2006), page 5.

APPENDIX D

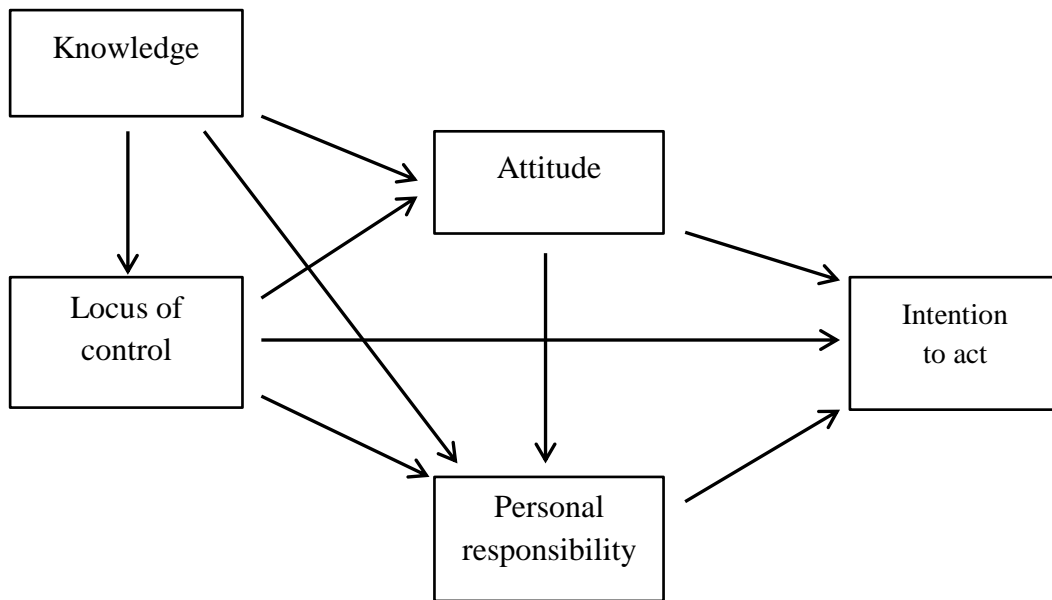
THE ENVIRONMENTAL CITIZENSHIP BEHAVIOR MODEL



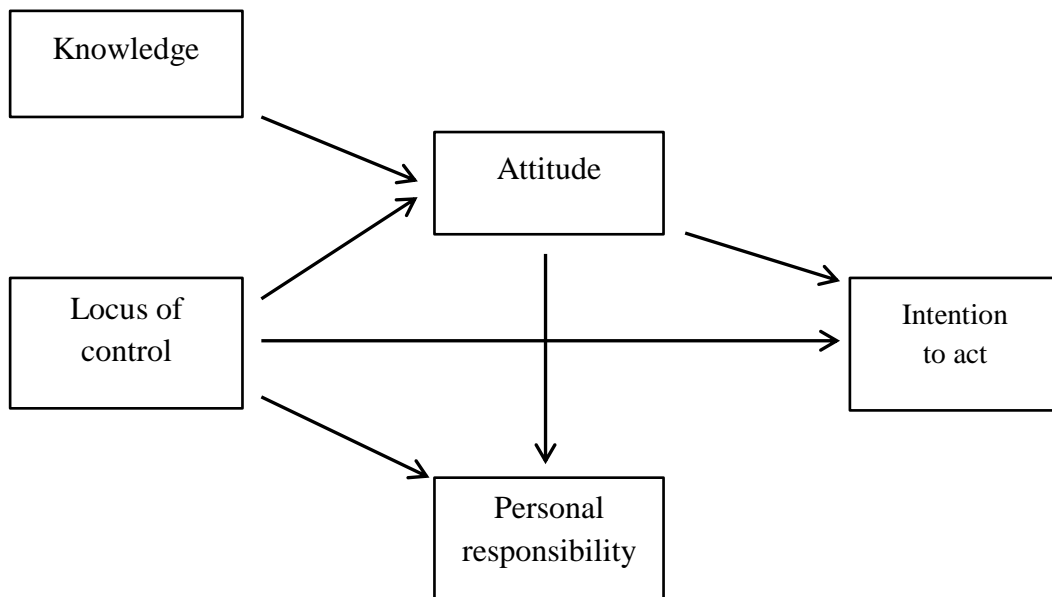
From Hungerford & Volk (1990), page 11.

APPENDIX E
THE HWANG ET. AL MODEL

Predicted Effects



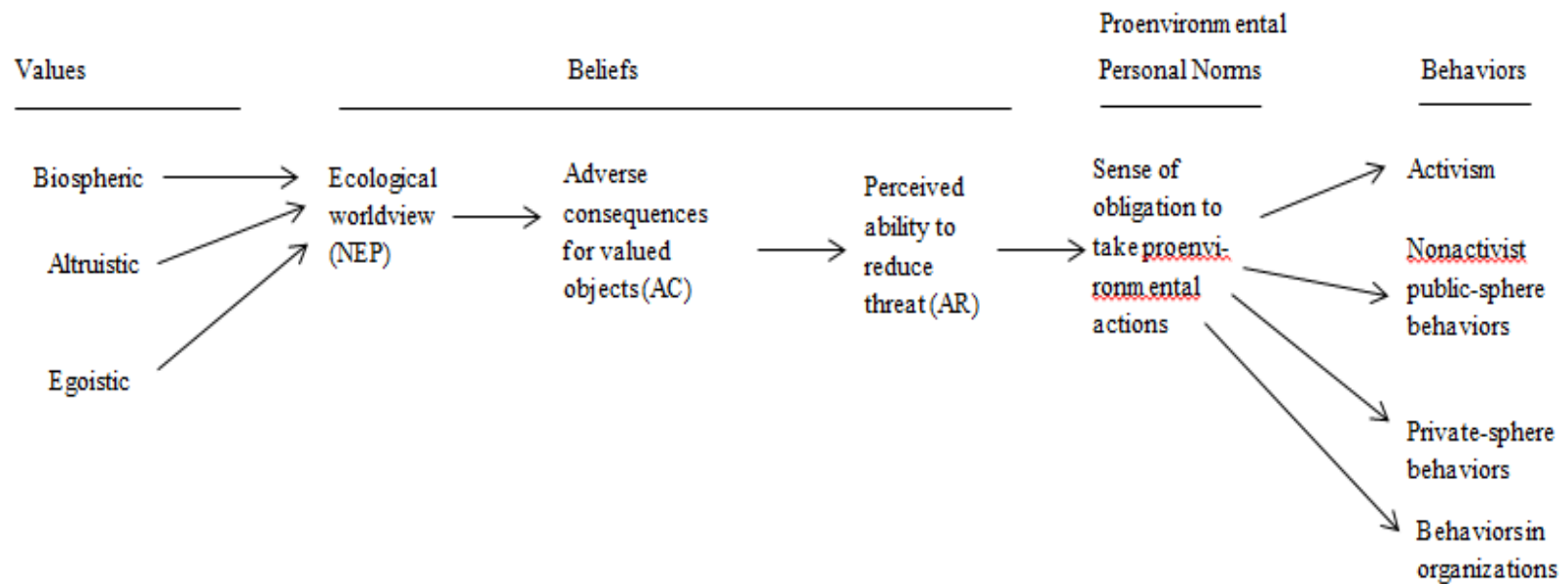
Actual Effects



Adapted from Hwang, Kim, & Jeng (2000).

APPENDIX F

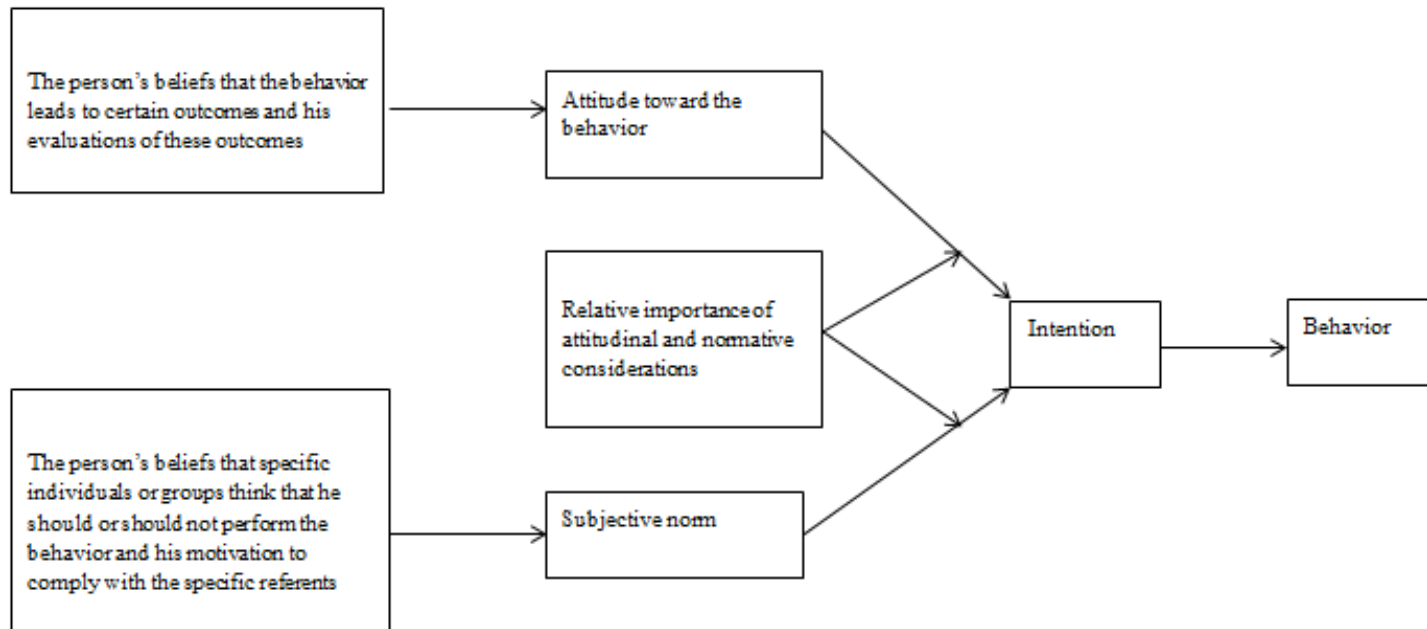
THE VALUE-BELIEF-NORM THEORY OF ENVIRONMENTALISM



From Stern (2000), page 412.

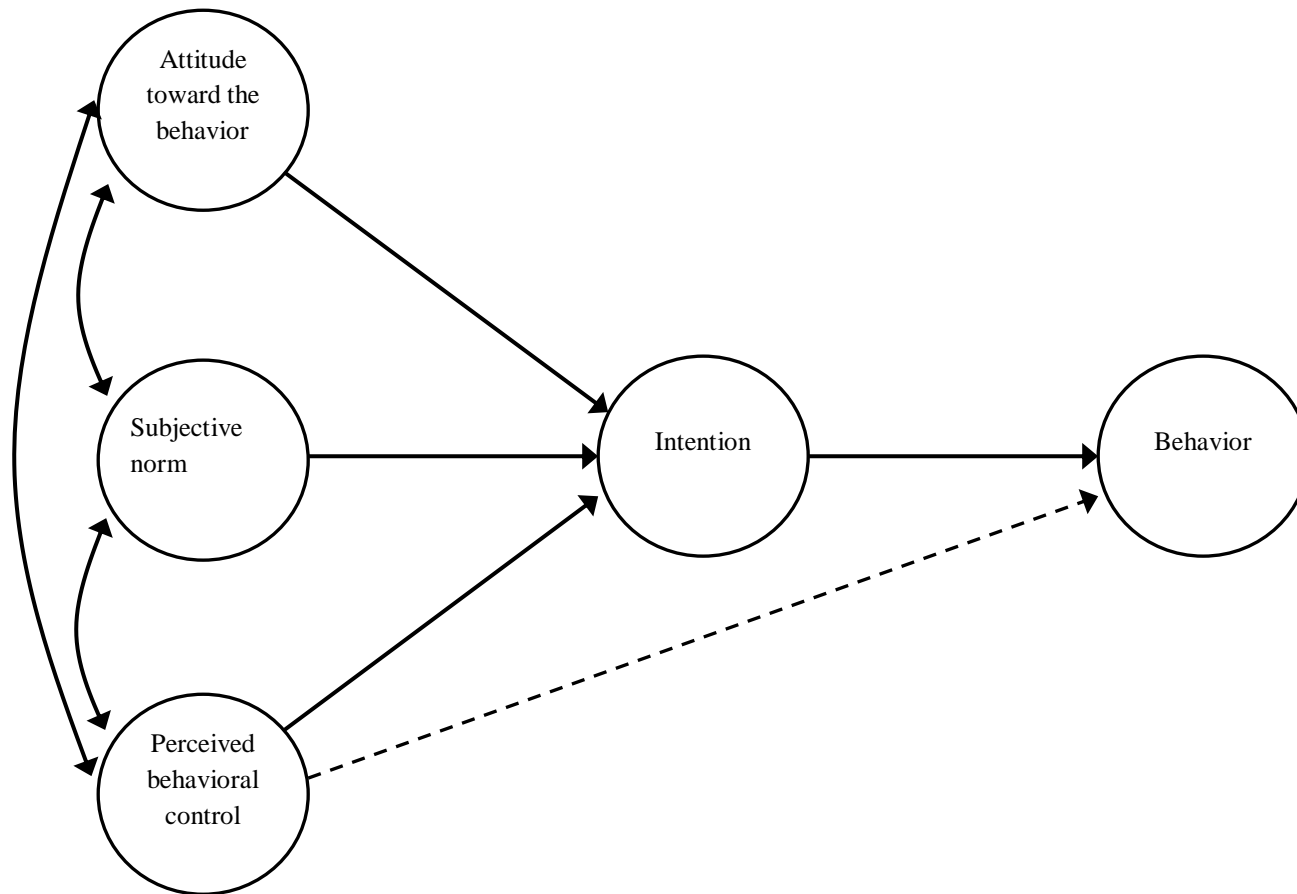
APPENDIX G

THE THEORY OF REASONED ACTION



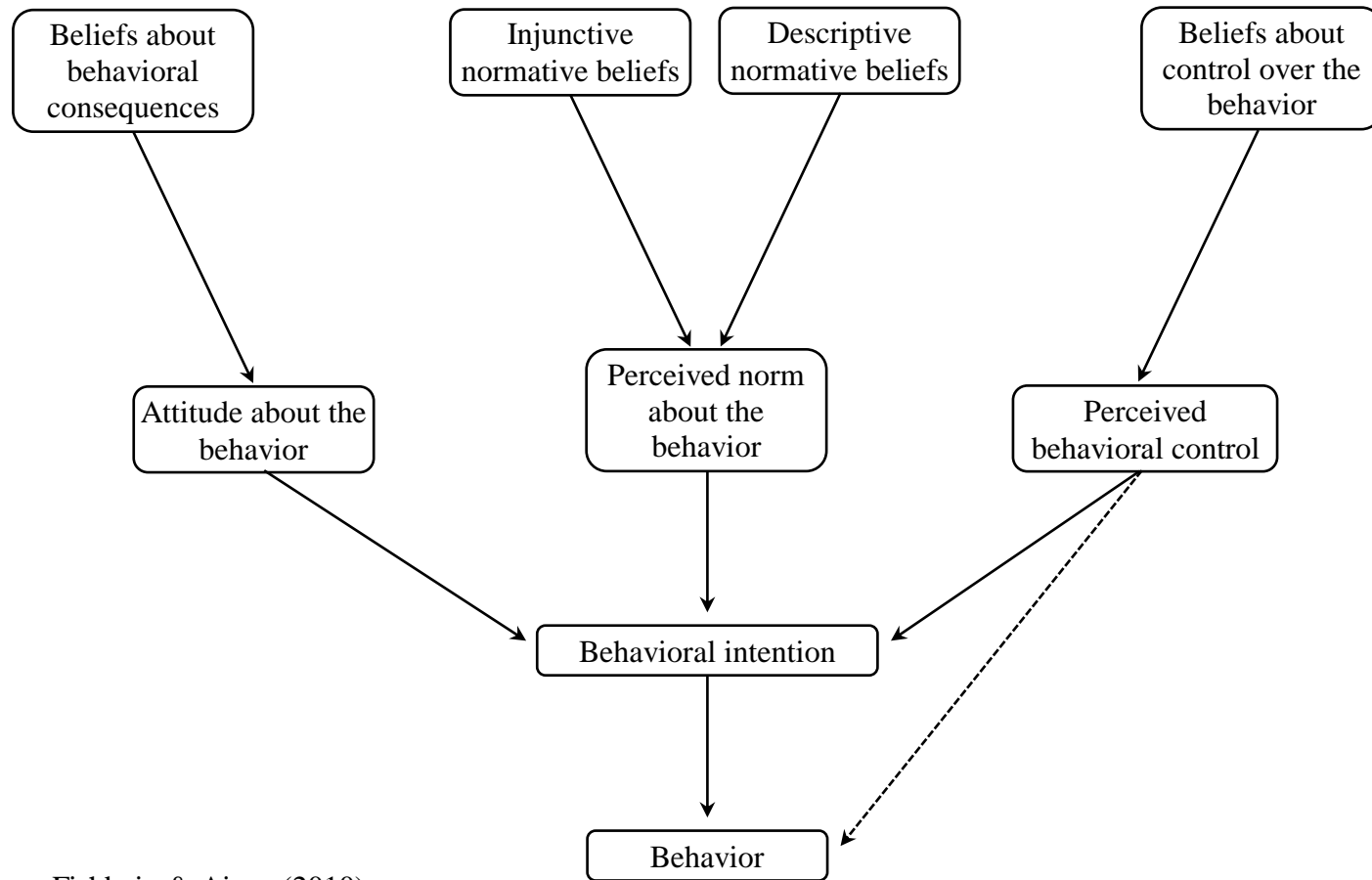
From Ajzen & Fishbein (1980), page 8.

APPENDIX H
THE THEORY OF PLANNED BEHAVIOR



From Ajzen (1991), page 182.

APPENDIX I
THE REASONED ACTION APPROACH



Adapted from Fishbein & Ajzen (2010).

APPENDIX J

APPROVED IRB APPLICATION

Application for Approval of Projects Which Use Human Subjects

This application is used for projects/studies that cannot be reviewed through the exemption process.



Institutional Review Board
Dr. Robert Mathews, Chair
131 David Boyd Hall
Baton Rouge, LA 70803
P: 225-578-8692
F: 225-578-6792
irb@lsu.edu
lsu.edu/irb

- Applicant, Please fill out the application in its entirety and include two copies of the completed application as well as parts A-E, listed below. Once the application is completed, please submit to the IRB Office for review and please allow ample time for the application to be reviewed. Expedited reviews usually takes 2 weeks. Carefully completed applications should be submitted 3 weeks before a meeting to ensure a prompt decision.
- A Complete Application Includes All of the Following:
 - (A) Two copies of this completed form and two copies of part B thru E.
 - (B) A brief project description (adequate to evaluate risks to subjects and to explain your responses to Parts 1&2)
 - (C) Copies of all instruments to be used.
 - *If this proposal is part of a grant proposal, include a copy of the proposal and all recruitment material.
 - (D) The consent form that you will use in the study (see part 3 for more information.)
 - (E) Certificate of Completion of Human Subjects Protection Training for all personnel involved in the project, including students who are involved with testing or handling data, unless already on file with the IRB. Training link: (<http://phrp.nhtaining.com/users/login.php>.)
 - (F) IRB Security of Data Agreement: (<http://www.lsu.edu/irb/IRB%20Security%20of%20Data.pdf>)

1) Principal Investigator*: James Wandersee

Rank Faculty

*PI must be an LSU Faculty Member

Dept:

ETPP

Ph:

225-758-2348

E-mail:

jwander@lsu.edu

2) Co Investigator(s): please include department, rank, phone and e-mail for each

Kathryn March, ETPP, grad student, 225-726-1410, kmarch1@lsu.edu

3) Project Title:

The Impact of an Informal Science Learning Environment on the Environmentally Responsible Behavior of Adults: A Case Study

4) Proposal Start Date: 11/16/2011

5) Proposed Duration Months: 3

6) Number of Subjects Requested: 50

7) LSU Proposal #:

8) Funding Sought From: n/a

ASSURANCE OF PRINCIPAL INVESTIGATOR named above

I accept personal responsibility for the conduct of this study (including ensuring compliance of co-investigators/co-workers) in accordance with the documents submitted herewith and the following guidelines for human subject protection: The Belmont Report, LSU's Assurance (FWA00003892) with OHRP and 45 CFR 46 (available from <http://www.lsu.edu/irb>). I also understand that copies of all consent forms must be maintained at LSU for three years after the completion of the project. If I leave LSU before that time, the consent forms should be preserved in the Departmental Office.

Signature of PI

James H. Wandersee

Date 10/4/11

ASSURANCE OF STUDENT/PROJECT COORDINATOR named above. If multiple Co-Investigators, please create a "signature page" for all Co-Investigators to sign. Attach the "signature page" to the application.

I agree to adhere to the terms of this document and am familiar with the documents referenced above.

Signature of Co-PI (s)

K. March

Date 10/4/2011

IRB# 3220	LSU Proposal #
<input type="radio"/>	Full
<input checked="" type="radio"/>	Expedited
<input checked="" type="radio"/>	Human Subjects Training
<input checked="" type="radio"/>	Complete Application

Study Approved By: Dr. Robert C. Mathews, Chairman Institutional Review Board Louisiana State University 203 B-1 David Boyd Hall 225-578-8692 www.lsu.edu/irb Approval Expires: 1-29-2013
--

Part 1: A. Is a HIPAA Agreement Needed?

Are you obtaining any health information **from a health care provider** that contains any of the identifiers listed below?

A. Names

B. Address: street address, city, county, precinct, ZIP code, and their equivalent geocodes. Exception for Zip codes: the initial three digits of the ZIP Code may be used, if according to current publicly available data from the Bureau of the Census: (1) The geographic unit formed by combining all ZIP codes with the same three initial digits contains more than 20,000 people; and (2) the initial three digits of a ZIP code for all such geographic units containing 20,000 or fewer people is changed to '000'. (Note: The 17 currently restricted 3-digit ZIP codes to be replaced with '000' include: 036, 059, 063, 102, 203, 556, 692, 790, 921, 830, 831, 878, 879, 884, and 893.)

C. Dates related to individuals

i. Birth date

ii. Admission date

iii. Discharge date

iv. Date of death

v. And all ages over 89 and all elements of dates (including year) indicative of such ages. Such ages and elements may be aggregated into a single category of age 90 or older.

D. Telephone numbers;

E. Fax numbers;

F. Electronic mail addresses;

G. Social security numbers;

H. Medical record numbers; (including prescription numbers and clinical trial numbers)

I. Health plan beneficiary numbers;

J. Account numbers;

K. Certificate/license numbers;

L. Vehicle identifiers and serial numbers including license plate numbers;

M. Device identifiers and serial numbers;

N. Web Universal Resource Locators (URLs);

O. Internet Protocol (IP) address numbers;

P. Biometric identifiers, including finger and voice prints;

Q. Full face photographic images and any comparable images; and

R. Any other unique identifying number, characteristic, or code; except a code used alone or in combination with other information to identify an individual who is the subject of the information.

- ☐ **YES** Your study falls under the HIPAA (Health Information Privacy and Accountability Act) and you must obtain either a limited data set agreement or a HIPAA authorization agreement from the health care provider. This agreement must be submitted with your IRB protocol.
- ☒ **NO** You do not need a HIPAA agreement.

B. Are pregnant women specifically excluded from participation on the consent form?

- ☐ **YES** Skip to Part C.
- ☒ **NO** You need to document the following:

- ☐ 1. Is the purpose of the activity to meet the health needs of the mother and -
- ☐ a. Fetus will be placed at risk only to minimum to meet mothers needs.
- ☒ b. Fetus risk is minimal.
- ☒ 2. Have mother and father given informed consent including potential affects on the fetus?
- ☒ 3. Father's consent to be omitted when:
- ☐ a. Purpose of activity is to meet health needs of the mother
- ☐ b. His identity can not be ascertained
- ☒ c. He is not reasonably available
- ☐ d. Pregnancy is from rape

C. Are any of your participants incarcerated?

☐ **YES** - You must document the following information:

- ☐ 1. Is the study minimal risk? (it must be)
- ☐ 2. Research fits one of the allowed categories below
 - ☐ Causes or effects of incarceration
 - ☐ Study of prisons or prisoners
 - ☐ Conditions affecting prisoners as a class
 - ☐ Practices that may improve health or well-being of subjects
- ☐ 3. Are the risks commensurate with risks accepted by non-prisoners?
 - ☐ Selection of subjects is fair - controls random
 - ☐ Language is understandable
 - ☐ Study does not affect parole
 - ☐ If necessary, follow up care will be provided

• **NO**

D. Are children involved?

☐ **YES** - You need both parental consent form and a child assent form

- If the study has greater than minimal risk and no direct benefits, then you must show that the
- ☐ risk is only a minor increase above minimal, and it involves experiences that are commensurate with ordinary medical, psychological, social or educational situations

• **NO**

Part 2: Project Abstract - Provide a brief abstract of the project

☒ I have attached a project abstract to this application

Part 3: Research Protocol

A. Describe study procedures

Describe study procedures with emphasis on those procedures affecting subjects and safety measures. Also provide script telephone surveys.

☒ I have attached a description of my study procedures to this application

B. Answer each of the following questions

1. Specify sites of data collection
California Academy of Sciences, San Francisco, CA

2. If surgical or invasive procedures are used, give name, address, and telephone number of supervising physician and the qualifications of the person(s) performing the procedures. Comparable information when qualified participation is required or appropriate.

n/a

3. Provide the names, dosage, and actions of any drugs or other materials administered to the subjects and the qualifications of the person(s) administering the drugs.

n/a

4. Detail all the physical, psychological, and social risks to which the subjects may be exposed.

Participants might feel uncomfortable discussing their personal decisions or actions during the interviews.

Participants' identities might be inadvertently released.

5. What steps will be taken to minimize risks to subjects?

Participant confidentiality will be maintained using a coding system for consent forms and interview transcripts.

Participant confidentiality will be maintained through the use of pseudonyms in any published works.

Participants may withdraw themselves or their interview transcripts from the study at any time.

6. Describe the recruitment pool (community, institution, group) and the criteria used to select and exclude subjects.

Participants will be recruited from visitors to the California Academy of Sciences.

Potential candidates will be identified based on:

- 1) time spent in the exhibit
- 2) interactive behaviors (e.g. pointing, touching) while in the exhibit

Potential candidates will be excluded if they:

- 1) are under 18 years of age
- 2) are visiting the museum with anyone under 18 years of age
- 3) are part a group of more than 4 people

7. List any vulnerable population whose members are included in this project (e.g., children under the age of 18; mentally impaired persons; pregnant women; prisoners; the aged).

Pregnant women will not need to be excluded from this study. The potential risks to a fetus are minimal to nonexistent.

8. Describe the process through which informed consent will be obtained. (Informed consent usually requires an oral explanation, discussion, and opportunity for questions before seeking consent form signature.)

Candidates meeting the requirements listed above will be approached with a verbal explanation of the general purpose of the interview (for visitors to share their recent experience in the Altered State exhibit). Those who agree to be interviewed will have the opportunity to ask questions before signing a consent form and again at the end of the interview.

The consent form will also cover the follow-up phone interview. The second interview will still begin with a verbal explanation of the purpose (to continue the first interview) and again, two opportunities for participants' questions will be given.

9. (A) Is this study anonymous or confidential? (Anonymous means that the identity of the subjects is never linked to the data, directly or indirectly through a code system.)

(B) If a confidential study, detail how the privacy of subjects and security of their data will be protected.

This study is confidential because it is necessary to connect participants' contact information (i.e. names and phone numbers) to the first interview data, as this data will be referenced in the second interview.

Consent forms and interview data will be numerically coded to maintain the confidentiality of participants. Consent forms will be kept in a locked filing cabinet for 3 years beyond the completion of the study, as required by IRB regulations. After this period of time, they will be destroyed (i.e. shredded)

Participants' real identities will never be used in any publications; pseudonyms will be used whenever referring to specific individuals.

Part 4: Consent Form (Including Assent Form and Parental Permission Form if minors are involved)

▷ **Please note:** The consent form must be written in non-technical language which can be understood by the subjects. It should not contain any exculpatory language through which the participant is made to waive, or appears to be made to waive any legal rights, including the right to sue.

▷ For example consent forms and a complete checklist of required items, please refer to our website, www.lsu.edu/irb. Remember, **contact information must be included** on the consent form!

▷ To waive signed consent, IRB must be provided with the **consent script** that will present the informed consent information to human subjects regarding the study/research. Also, note that waiving signed consent required full IRM approval, which may delay approval of your study.

I am requesting waiver of signed Informed Consent because:

- ☐ (a) Having a participant sign the consent form would create the **principal risk** of participating in the study.

or that

- ☐ (b) The research presents **no more than minimal risk** of harm to subjects and involves no procedures for which having signed consent is normally required.

Expedited review usually takes 2 weeks. See our website for information about meeting dates. Carefully completed applications should be submitted 3 weeks before a meeting to ensure a prompt decision.

Institutional Review Board
Dr. Robert Mathews, Chair
131 David Boyd Hall
Baton Rouge, LA 70803
P: 225.578.8692
F: 225.578.6792
irb@lsu.edu
lsu.edu/irb

Print Form

Project Description

The purpose of this exploratory case study is to answer the question “How does the *Altered State: Climate Change in California* exhibit influence the intended and actual environmentally responsible behaviors of adult visitors to the California Academy of Sciences?” The study will involve observing and interviewing adult visitors to the Academy, a public science museum in San Francisco, CA. Prior to conducting interviews, visitor behavior (e.g., paths they choose, body movements, interactions with staff or other visitors) will be observed as unobtrusively as possible by the co-investigator.

Two post-visit interviews will be conducted. Up to 50 visitors who meet the criteria for recruitment (i.e., minimum of 18 years of age, minimum of 10 minutes spent in the exhibit, performance of interactive behaviors while in the exhibit, and visiting either alone or with 1-3 other adults) will be asked to participate in face-to-face exit interviews. The second interview will be a follow-up phone interview with the same individuals several weeks later. None of the participants will be prisoners or children. Due to the nature of the study, pregnant women do not need to be excluded as there is little to no risk to a fetus.

The main risk is that participants might become uncomfortable while discussing their personal decisions or actions during the interviews. To protect subjects, the study will be fully explained to them and they will have opportunities to ask questions. They may remove themselves or their statements from the study at any time. Also there is a slight risk that participant’s identities could be revealed. Each participant consent form will have a unique code which will be used instead of names when labeling data. Participant confidentiality will further be maintained by the use of pseudonyms in any publications.

Consent Form

Study Title: The impact of an informal science learning environment on the environmentally responsible behavior of adults: A case study

Performance Site: California Academy of Sciences, San Francisco, CA

Investigators: The following investigators are available for questions about this study:
Dr. James Wandersee, 223F Peabody Hall, College of Education, LSU (225) 578-2348, (e-mail: jwander@lsu.edu)
Kathryn March, 328 Peabody Hall, College of Education, LSU (225) 726-1410 (email: kmarch1@lsu.edu)

Purpose: To develop an understanding of the messages and meanings visitors take away from the *Altered State: Climate Change in California* exhibit.

Subject Inclusion: Adult visitors to the California Academy of Sciences

No. of Participants: 50

Study Procedures: This study will involve one 6-8 hour observation of the exhibit, **a 15-30 minute face-to-face interview with each participant, and a 10-20 minute follow-up phone interview with each participant.**

Benefits: This study may reveal valuable information about exhibits which can improve future exhibits at CAS and other science museums.

Risks: The only study risk is the inadvertent release of your identity. However, every effort will be made to maintain your confidentiality. Files will be kept in secure cabinets to which only the investigators have access.

Right to Refuse: Participation is voluntary. You may choose not to participate, and you have the right to withdraw from the study at any time without penalty.

Privacy: The results of the study may be published, but no names or identifying information will be included in the publication. Your identity will remain confidential unless disclosure is required by law.

Signatures: The study has been discussed with me and all my questions have been answered. I agree to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of this consent form. If I have questions about subjects' rights or other concerns, I can contact Robert C. Mathews, Institutional Review Board, (225) 578-8692, irb@lsu.edu , www.lsu.edu/irb.

Subject Signature _____ **Date** _____

Name (please print) _____ **Phone (_____)** _____



****Please sign and submit this document with your IRB application****

Security of Data

Number: PS06.20

SECURITY OF DATA

PURPOSE

I certify that I have read and will follow LSU's policy on security of data – PS06.20 (http://itsweb.lsu.edu/ITS_Security/IT_Policies/LSU/item614.html) and will follow best practices for security of confidential data (http://itsweb.lsu.edu/ITS_Security/Best_Practices/Sensitive_Data/item862.html) This Policy Statement outlines the responsibilities of all *users* in supporting and upholding the security of *data* at Louisiana State University regardless of *user's* affiliation or relation with the University, and irrespective of where the *data* is located, utilized, or accessed. All members of the University community have a responsibility to protect the confidentiality, integrity, and availability of *data* from unauthorized generation, access, modification, disclosure, transmission, or destruction. Specifically, this Policy Statement establishes important guidelines and restrictions regarding any and all use of *data* at, for, or through Louisiana State University. This policy is not exhaustive of all *user* responsibilities, but is intended to outline certain specific responsibilities that each *user* acknowledges, accepts, and agrees to follow when using *data* provided at, for, by and/or through the University. Violations of this policy may lead to disciplinary action up to and including dismissal, expulsion, and/or legal action. It is recommended that all personnel on your project be familiar with these policies and requirements for security of your data.

In addition it is recommended that PIs review any grant, non-disclosure/confidentiality agreement, or restricted data agreements before publishing articles using the data.

I certify that I have read and understand these policies

Name: K March

Date: 10/4/2011

APPENDIX K
OBSERVATION PROTOCOL

Location: _____ Date: _____ Time: _____

Observations	Reflections

APPENDIX L

FACE-TO-FACE INTERVIEW PROTOCOL

Warm up questions:

- Where are you from? Have you ever been to the California Academy of Sciences before? How many times? Have you seen this exhibit before? How many times?

Exhibit questions:

- How much time would you say you spent in the *Altered States* exhibit today?
- What were your general impressions of the exhibit?
- What, if any, parts of the exhibit interested you the most?
- What, if any, ideas or messages did you take away from the exhibit?
 - How successful do you feel the exhibit was in conveying these messages?
 - How do you think these messages might affect your future actions, or the actions of others who visit this museum?
- Would you share with me some of the things you currently do (at home, school, or work) that you consider environmentally responsible?
- What, if any, suggestions do you recall from the exhibit about environmentally responsible actions?
 - How do you think these suggestions might influence your future actions, or the actions of others who visit this museum?

Additional prompts:

- Can you tell me more?
- What else / what others? / What other ways?
- What else / others can you remember?
- Anything else / any others?

Wrap-up questions:

- Is there anything else you would like to share with me about environmental actions, this exhibit, or the California Academy of Sciences in general?
- Do you have any questions for me?
- I would like to review your responses with you to be sure I've recorded them accurately and completely. Would that be OK?

APPENDIX M

FOLLOW-UP PHONE INTERVIEW PROTOCOL

Warm up questions:

- Have you been back to the Academy since we spoke last?

Exhibit questions:

- What, if any, ideas or messages do you remember from the exhibit?
- What, if any, suggestions about environmental actions do you remember from the exhibit?
- When we spoke last, you told me of some things you were doing back in November that you considered environmentally responsible / you were not doing anything you considered environmentally responsible. What, if any, environmentally responsible actions are you taking now?
- What effect, if any, do you think seeing the exhibit had on you?
- Are there other environmental actions you would like to take, but feel that you can't right now? (If yes: what do you think keeps you from being able to do them?)

Additional prompts:

- Can you tell me more?
- What else / what others? / What other ways?
- What else / others can you remember?
- Anything else / any others?

Wrap-up questions:

- Is there anything else you would like to share with me?
- Do you have any questions for me?
- I would like to review your responses with you to be sure I've recorded them accurately and completely. Would that be OK?

APPENDIX N
DEMOGRAPHIC SURVEY QUESTIONS

The following questions are for informational use only and will be kept strictly confidential.

Gender: ☐ male ☐ female

Age: ☐ 18-29 ☐ 30-39 ☐ 40-49 ☐ 50-59 ☐ 60-69 ☐ 70-79 ☐ 80+

Highest level of education completed: ☐ some high school ☐ high school diploma
☐ some college ☐ undergraduate degree ☐ graduate or professional degree ☐ other

Ethnicity: ☐ African American ☐ Asian/Pacific Islander ☐ Latino ☐ American Indian
☐ White (non-Hispanic) ☐ other: _____ ☐ prefer not to answer

Current Occupation: _____

APPENDIX O

EXCERPT FROM AN INTERVIEW TRANSCRIPT

Context: This is a 4-minute excerpt from an 18-minute interview with two friends, Richard and Travis (pseudonyms). It is a good representation of how most of the interviews flowed.

Kate: Have either of you seen this exhibit before today?

Richard: I have not.

Travis: No.

Kate: Okay.

Richard: Nor have I been to this building before.

Kate: Yeah, it's pretty neat, huh?

Richard: Yeah... I like the... the whole design.

Kate: So what were your general impressions of the *Altered States* exhibit?

Richard: Well I- see I, I liked it a lot. I think that there's not enough museums across the US that have that kind of a science, uh, background that explain it in depth... and there needs to be more, and they need to do a better job of educating the public about it. That being said, I agree with whatever's on the walls there, um, and I think they did a very good job in laying it out, so...

Kate: okay... Travis?

Travis: well, what I was gonna say is-is similar to what Richard said, is that... San Francisco is probably the last place that needs this... most of the rest of the country is what needs this. Um... [pauses] because...

Kate: Why do you say that?

Travis: Well, why I say that is I still don't think that most of the country realizes just what a problem climate change and global warming is [**Richard:** yep] and the havoc its wreaking... um... I- I think a lot of people in San Francisco understand it, but I think most of the country does not [**Richard:** yeah] so... can be, its- its- it's nice here, but it's probably the last place it's needed... is my... [drifts off, chuckles]

Kate: Okay. Sure.

Travis: And, yeah- and Richard and I pretty much agree... and I know that I'm speaking for both of us when I say this... we pretty much agree with everything that's behind us there.

Richard: Yeah.

Kate: Okay.

Travis: So.

Kate: What messages do you think the Academy is trying to get across with this exhibit?

Richard: Um, I think that they were trying to get across is, that, uh, well obviously the dangers of what kind of, I mean, CO₂ emissions, the more CO₂ that's getting into the atmosphere, the dangers are intensifying for the planet... um, the amount that's, that's going,

that's be given off, say you take an airplane, or an SUV, I mean, that's gonna create more... uh, you know, so that's gonna be an issue... and it wants to let you know what you possibly could do to minimize it, of course... and that I took some of that away from the wall itself, so...

Kate: Sure.

Travis: Uh, so what's the question again? I'm sorry... [chuckles]

Kate: Just, what do- what messages do you think the Academy was trying to convey?

Travis: Just the, uh, the problem, what's causing it, um... the fact that, um, it's causing problems in terms of extinction, in terms of... ocean temperatures, in terms of extreme weather conditions, um, certain states and areas that are getting drier, and um.... there's certain places like New Jersey, that are getting wetter, um... from experience, so...

Kate: Okay. Um, and how successful do you think they were at, giv- at passing those messages on to the public?

Travis: I think they're very successful. Now, I think it's like any type of drug that somebody takes. I think everybody reacts differently to it. Um, the people here, I think, to dovetail on what he said, is that the people are going to take it... that some will pay closer attention to it, some people will act on it, some will just naturally just, not act on it, I mean, you'll get a hybrid of that... I think the people who come here are gonna be more receptive to it, um... people in Boston will be... I think the people, I think it depends on who the person is. Some people don't want to know about it, and then, you know, it's not gonna do much good, so.

Kate: Okay.

Travis: You want my honest opinion?

Kate: Yes.

Travis: I think it's a very minimal impact [**Kate:** okay] um, on the public at large. In fact, my- my, my commentary that I left on the message board was that you need... mandatory restrictions on emissions... just having a couple of good- do-gooders buy hybrids is insufficient in my opinion, because that's why I don't own one, because if one out of every 100 people owns one, its, I mean it's such a minimal, minimal...

Kate: Mm-hmm.

Richard: Right.

Travis: Um, like I think if unless you have mandatory... mandatory hybrids, mandatory restrictions on emissions, all the things that nobody wants, [**Richard:** right] um, I think you're doing to deal with the problem. And also, I has to be global [**Richard:** right] it can't just be the US that's doing it, it's gotta be every country [**Richard:** right] and it's tough to tell... India or China or whatever country, that are in various stages of industrial development [**Richard:** right] that you can't do what we did all those years to help ourselves grow, so it's... [pauses]

Kate: Right.

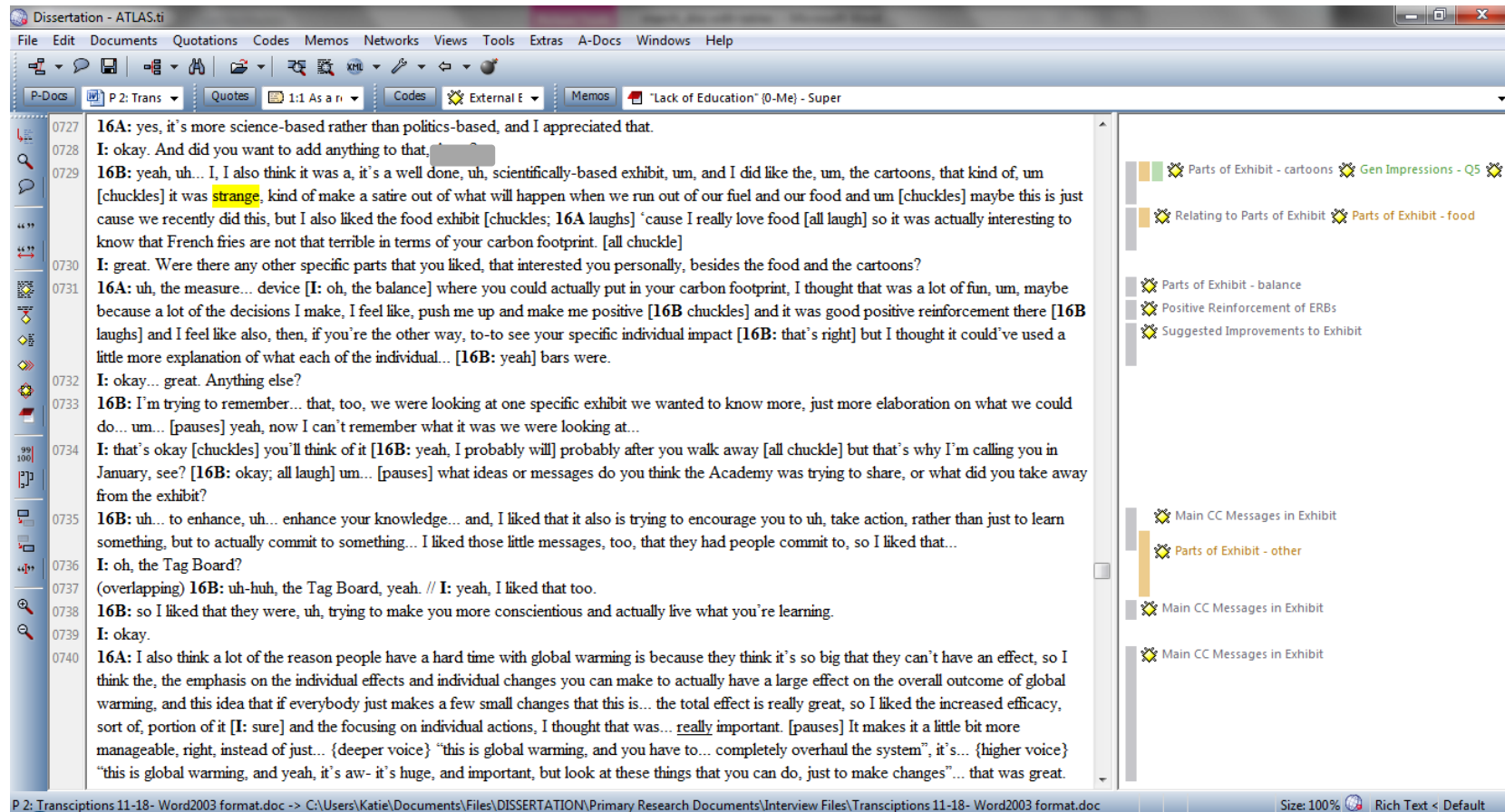
Travis: It's- it's- it's- it's a tough position, but- but I think, I- I hate to say it but one little exhibit one science museum is going to have a very, very minimal impact on policy...

(interrupts) **Richard:** That being said...

Travis: Even though we agree with it 100%.

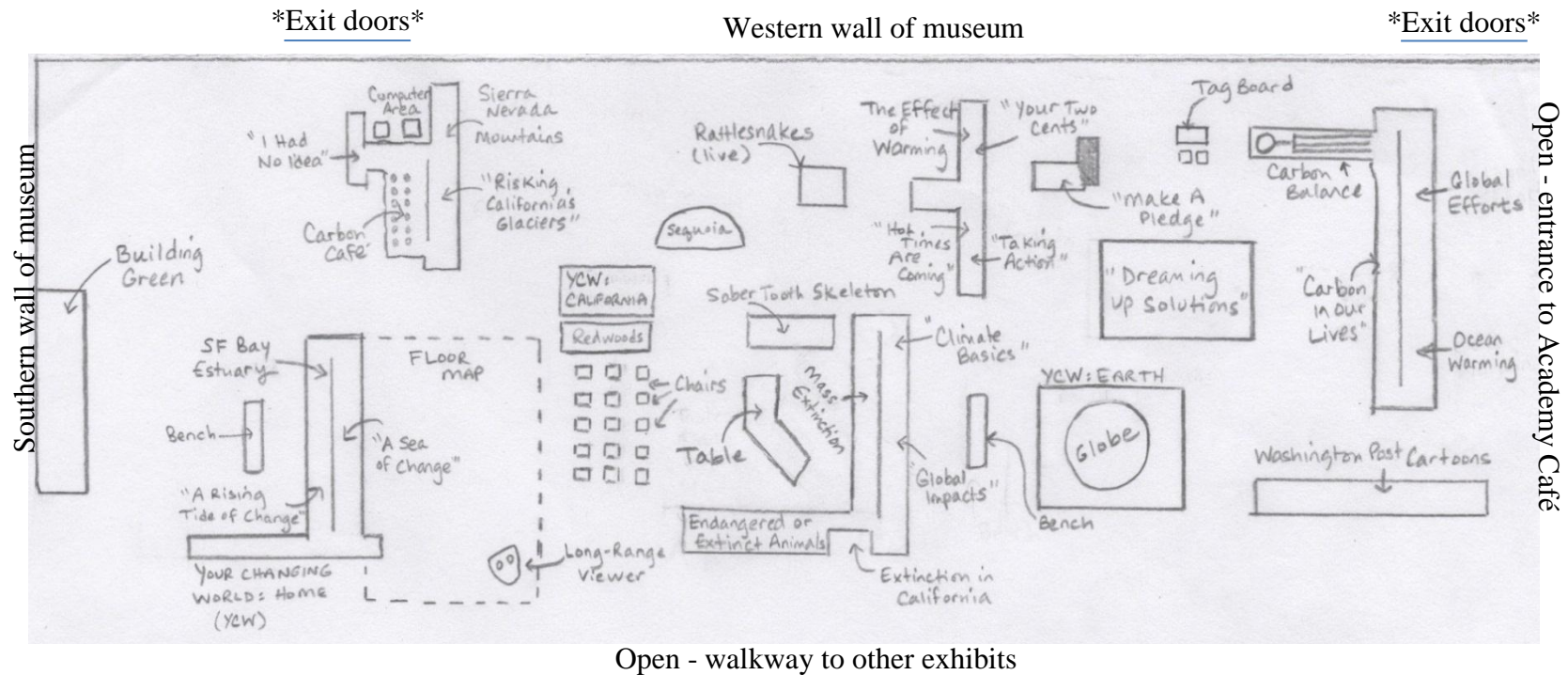
APPENDIX P

SCREEN SHOT OF ATLAS.ti



APPENDIX Q

LAYOUT OF ALTERED STATE: CLIMATE CHANGE IN CALIFORNIA



VITA

Growing up in the rural town of Chepachet, Rhode Island, instilled a profound connection with the natural world in Kathryn Ann March. She originally attended the University of Rhode Island with plans to become a veterinarian, but after earning a Bachelor of Science in Zoology degree (1998) her career path took a number of unexpected turns. After working at animal hospitals, zoos, and a biotech company, Kathryn decided to begin teaching. She spent several years as a high school biology and oceanography teacher in Westborough, Massachusetts. That decision eventually led to her return to academia to pursue an advanced degree in science education. She has since earned a Master of Education degree (2010) and an Education Specialist certification (2011) from Louisiana State University.

Kathryn began working at Bluebonnet Swamp Nature Center in Baton Rouge not long after relocating to Louisiana in 2007. There she had many valuable experiences as an informal science educator, presenting nature-based programs and designing environmentally-focused curricula for learners ages 2 - adult. She recently presented her ideas for using technology in the science classroom at an annual meeting of the National Association of Biology Teachers, and has also been published in *The American Biology Teacher* and *LSU Science Talk*. She is a member of the National Association of Biology Teachers, the National Science Teachers Association, and the North American Association for Environmental Education.

Following the completion of her doctoral program, Kathryn initially plans to return to teaching at the high school level in the New England area. Her long term goals include improving environmental education for all learners through the creation of enhanced training/professional development programs for formal and informal science educators.